Technical Report Documentation Page

1. REPORT No.

2. GOVERNMENT ACCESSION No.

3. RECIPIENT'S CATALOG No.

4. TITLE AND SUBTITLE

Experience With the Progress and Final Record Sampling of Construction Materials

5. REPORT DATE

December 1964

6. PERFORMING ORGANIZATION

7. AUTHOR(S)

Lyman R. Gillis

8. PERFORMING ORGANIZATION REPORT No.

9. PERFORMING ORGANIZATION NAME AND ADDRESS

State of California
Highway Transportation Agency
Department of Public Works
Division of Highways

10. WORK UNIT No.

11. CONTRACT OR GRANT No.

13. TYPE OF REPORT & PERIOD COVERED

12. SPONSORING AGENCY NAME AND ADDRESS

14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

Presented at the 50th Annual AASHO Meeting Atlanta, Georgia December 7-11, 1964

16. ABSTRACT

The record sampling program, which was initiated on a nationwide basis by the Bureau of Public Roads in May of 1960, has been the subject of several articles since its inception. A comprehensive discussion of the ramifications involved and the general approach to the program by California and several other states was presented in a paper by F.N. Hveem, former Materials and Research Engineer, in December 1962.

The purpose of this presentation is primarily to update the material presented in the 1962 paper, particularly with respect to quality and, to a certain extent, construction control of highway materials. Particular emphasis will be placed upon the results of the more recently instigated progress sampling and testing phase of the record sampling program, which has been in operation for slightly over two years. The approach of several other western states to the progress record sampling program will also be outlined.

It would be appropriate to very briefly review the history of California's involvement in the record sampling program. If it were necessary to sum up the reasons for the existence of a State Highway Materials and Research Department in two words, these two words would, of necessity, be "Quality Control".

17. KEYWORDS

18. No. OF PAGES:

42

19. DRI WEBSITE LINK

http://www.dot.ca.gov/hq/research/researchreports/1964-1965/64-02.pdf

20. FILE NAME

64-02.pdf

STATE OF CALIFORNIA
HIGHWAY TRANSPORTATION AGENCY
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

EXPERIENCE WITH THE PROGRESS AND FINAL RECORD SAMPLING OF CONSTRUCTION MATERIALS

By
Lyman R. Gillis
Assistant State Highway Engineer
California Division of Highways

Presented at the 50th Annual AASHO Meeting
Atlanta, Georgia
December 7–11, 1964

64-02

EXPERIENCE WITH THE PROGRESS AND FINAL RECORD SAMPLING OF CONSTRUCTION MATERIALS

By

Lyman R. Gillis*

I. Introduction

The record sampling program, which was initiated on a nation-wide basis by the Bureau of Public Roads in May of 1960, has been the subject of several articles since its inception. A comprehensive discussion of the ramifications involved and the general approach to the program by California and several other states was presented in a paper by F. N. Hveem, former Materials and Research Engineer, in December 1962.**

The purpose of this presentation is primarily to update the material presented in the 1962 paper, particularly with respect to quality and, to a certain extent, construction control of highway materials. Particular emphasis will be placed upon the results of the more recently instigated progress sampling and testing phase of the record sampling program, which has been in operation for slightly over two years. The approach of several other western states to the progress record sampling program will also be outlined.

It would be appropriate to very briefly review the history of California's involvement in the record sampling program. If it

*Assistant State Highway Engineer, California Division of Highways
**"California's Experience with the Record Sampling Program", F. N. Hveem, Presented at the 48th Annual AASHO Meeting, Miami, Florida, December 4-7, 1962.

were necessary to sum up the reasons for the existence of a State Highway Materials and Research Department in two words, these two words would, of necessity, be "Quality Control".

In the years from the establishment of California's Laboratory in 1912 until the end of World War II, most routine testing of a control nature for going highway projects was carried out in the Materials and Research Department Laboratory in Sacramento. This was done in addition to the large amount of materials research and development. With the establishment of laboratories in the eleven highway districts, the Headquarters Laboratory oriented itself to a greater degree toward (1) research and development of new highway materials, testing methods and techniques, and (2) special investigations to determine the cause of distress or failures. Testing and sampling of a routine nature involving equipment or techniques beyond the scope of the district materials laboratories still represented 75% of the activities, however. Thus, as the Headquarters Laboratory became more heavily committed to research and special investigations, its direct involvement in routine quality tests on going highway construction projects diminished somewhat.

During the mid-1950's, as the result of several pavement distress investigations, it was noted that some structural sections were constructed to lesser thicknesses than planned and that some of the material entering into the work did not fully comply with specification requirements. At least one project, which had a planned 6" cement treated base (CTB), was constructed to thicknesses as low as 3-3/4", with an average thickness of 4-3/4".

Another project where 8" of CTB was planned, was found to have been constructed to an average thickness of only 5".

As a result of these investigations, the Materials and Research Department at the request of the Construction Department initiated a statewide sampling program in the summer of 1959. During this first summer, 34 cement treated base projects were cored throughout the State. At about this time, a special highway investigating committee of the House of Representatives, headed by Representative John A. Blatnik of Minnesota, uncovered evidence of poor workmanship, notably in the States of Oklahoma, New Mexico, and Florida. These discoveries prompted the Bureau of Public Roads to require evidence of compliance with specifications on construction of all federal aid highways. Instructional Memorandum 20-5-60 was issued, describing the details of the so-called Record Sampling and Testing Program. This program has been carried out on all newly completed state highways and FAS projects in California by the Materials and Research Department since May of 1960. The California Division of Highways applies this final record program to all highway projects, whether federally financed or not.

To briefly describe the final record sampling program, each newly completed project is sampled by a Headquarters Materials and Research Department coring crew at the rate of one sampling per lane mile of roadway. Measurements are made of the thickness of each planned layer and samples of the various materials are obtained. The results are tabulated and transmitted to appropriate Division of Highways personnel and to the Bureau of Public Roads.

Quality tests are also performed for research purposes. This program has produced a sufficiently large volume of control data to clearly identify certain interesting trends in quality and construction control of highway materials. These data will be examined in some detail in the following section.

II. Final Record Sampling Data

From the beginning of the Final Record Sampling Program until October 1964, a total of 7,914 samplings, representing 6,758 lane miles of new construction, have been made. A year-by-year tabulation of the accumulated final record thickness data is shown by Figures 1 through 7. Before we discuss the thickness data resulting from this sampling, it would be appropriate to clarify the terminology which is used to evaluate this material.

From the beginning of the program, it was obvious that some tolerance had to be allowed in thickness measurements which would reflect variations in acceptable construction, random differences in test areas selected, and the human error involved in making the thickness measurement. Consequently, a set of values for normal variation in thickness was adopted and has been used by the Materials and Research Department as a guide to judge the need for additional sample locations to establish the extent of unusual thickness variations. These values, shown by the table below, are, in general, more liberal than those permitted by our Standard Specifications.

Normal Variations in Random Samples
for
Thickness of Base and Pavement Layers

	80% of all test holes to be within the following tolerances		None to Exceed
	Minus	Plus	Minus
Aggregate Subbase	-0.10'	-	-0.20'
Road Mix CTB) Lime Treated Base) Bituminous Treated Base)	-0.08'	+0.12'	-0.15'
Aggregate Base	-0.05'	+0.08'	-0.10'
Plant Mixed CTB	-0.04'	+0.06'	-0.08'
Road Mixed Bituminous Surface	-0.03'	+0.05'	-0.06'
Asphaltic Concrete Pavement	-0.02'	+0.04'	-0.04'
Portland Cement Concrete Pavement	-0.01'	+0.03'	-0.02'

Note: To be used only for judging adequacy of pavement thickness as indicated by samples cut or cored at random locations.

It should be emphasized, however, that they are used only as a guide for the samplers to determine the necessity of additional check sampling, and are not to be considered any form of a specification thickness tolerance. Thus, a thickness deficiency in aggregate base in excess of 0.10' would be considered more than that which would be accumulated due to a local variation in the grading plane and measurement error so that additional sampling for check measurements would be required.

In general, as shown by Figures 1 through 7, the 1963 data reflects a continuing yearly trend toward closer conformance to planned thickness with a smaller percentage exceeding the normal variation. The steady improvement in performance is particularly apparent from the road mix CTB plot (Fig. 1), with 8% of the thicknesses deficient by more than 0.15' in 1959 as opposed to 1% in 1963.

The data for AC pavement (Fig. 3) indicates that in 1963 8% of the thickness measurements exceeded the planned amount by more than 0.04' normal variation as opposed to 29% in 1960. The percentage of samples on the thin side of normal variation increased from 1% in 1961 to 3% in 1963, indicating that the past tendency of many resident engineers to place AC surfacing by weight alone, with the intention of using all material allocated for the project, is diminishing.

The plot for slip form portland cement concrete paving (Fig. 4) placed in 1963 reveals a significantly improved performance, with 19% exceeding the planned thickness by more than the normal 0.03' variation as opposed to 30% in 1961.

This very encouraging trend toward improved construction control can, perhaps, be best illustrated by a comparison of 1960 and 1963 thickness data with that resulting from the AASHO Road Test, Figures 8 through 10.

There can be little argument that the degree of construction control exercised on the AASHO Road Test was uneconomical insofar as normal construction practice is concerned. As a matter of fact, it came as near as could be expected to eliminating all variances of construction except those inherent in the particular equipment and procedure used for the work. However, it can serve as a base line for comparison, beyond which it would not be practical to expect any improvement.

Quality control data resulting from the 4-year final record sampling program is shown by Figures 11 and 12. R-value test results clearly demonstrate the problems associated with control of local material sources, such as subbase, as compared to those from commercial plants or produced under stringent processing requirements, which is usually the case with aggregate base.

Aggregate base R-value data (Fig. 11) shows a slight but significant yearly improvement, with 3.9% failing in 1960 as compared to 0.5% in 1963. The aggregate subbase plot reflects very significant improvements from 1960 to 1962, with 10.9% failing in 1960 as compared to 1.2% failing in 1962. In 1963, 2.0% of the samples failed, which very possibly indicates that a point of diminishing return has been attained for this material. The aggregate base sand equivalent results (Fig. 12) reveal substantial year-by-year improvements from 1960 to 1962, with 23.9% failing to meet the specification requirements in 1960 as compared to 5.5% in 1962. Since a 1960 revision of the California Division of Highways Standard Specifications includes no provision that would produce materially cleaner aggregate base, this improvement can only be attributed to improved quality control processing equipment and techniques. The 1963 data indicates a leveling off, with 6% of the samples failing.

The aforementioned construction and quality control data reveal beyond any reasonable doubt that the record sampling program has stimulated a much greater interest and awareness of material control by construction personnel and contractors. It also reflects substantial progress in material processing and construction control. This is indeed gratifying since it is a well-known fact that sources of naturally suitable material are becoming increasingly hard to find.

III. Progress Record Sampling Program

On January 26, 1962, the Bureau of Public Roads issued a policy and procedure memorandum (20-6.2) outlining the requirements for the progress record sampling program. The intent of this program was the taking of "random samples" for "an independent spot check on the results shown by routine job control samples." Progress samples were to be "taken from materials delivered but not incorporated in the work and from construction work in progress." Progress samples could be taken by central laboratory personnel (which included district laboratory personnel) or by project personnel at locations indicated by and in the presence of either central laboratory personnel or the Public Roads area engineer, or both. The frequency of testing and tests to be performed were not delineated in this memorandum.

In response to this document, the California Division of Highways initiated the progress record sampling program for California by designating certain district laboratory personnel as "progress samplers." Progress samplers were instructed to visit going projects with sufficient frequency so that the number of progress samples would number approximately 10% of that taken for project control. Except for this general guideline with regard to frequency of sampling, no further specific instructions were issued with respect to the location or frequency of progress sampling. The reason for this was to maintain maximum flexibility of the progress sampling program so that progress samplers could concentrate in those areas where their activities might produce maximum benefits.

Because of certain variations in procedure, frequency, and type of testing accomplished by the various highway districts, however, it became apparent that a more systematic approach was necessary. Accordingly, in November, 1963, a progress record sampling schedule (Tables 1 through 6) was issued which clearly delineated sampling frequency, location, and type of test to be made for all materials subject to progress testing.

Probably one of the more important aspects of the progress sampling program was the fact that it placed a check on specification requirements at a time when it was still practical to take corrective action without removing excessive quantities of completed work. The reliance on final record samples for quality testing is unrealistic due to the many physical and chemical factors that can vary beyond the limits anticipated by the engineer.

Progress Sampling Procedures of the Various Western States

In order to compare progress sampling and testing procedures in the western part of the United States, a questionnaire was sent to seven neighboring states. The replies of seven states plus information pertinent to California are tabulated in Table 7.

Perusal of this table indicates that all of the eight states have established, to some degree, systematic progress sampling schedules with respect to both frequency and location of sampling. The State of Oregon has no predetermined sampling frequency but has established location of progress sampling for all categories of material. As was the case with respect to the final record sampling program, a considerable amount of variation was found to exist from state to state with regard to frequency of sampling. As an example, for aggregate base and subbase, Colorado samples at the rate of 1 per 4 lane miles. Idaho and Nevada obtain 1 progress sample at the rates of 1 per 25,000 tons and 1 per 10,000 tons, respectively. California and Hawaii sample at the rate of 1 progress sampling per 10 control samplings, which, in the case of California, would amount to approximately 1 progress sample per 30,000 tons.

For P.C.C. aggregate, the rate varies from 1 sampling per month (Hawaii) to 1 sampling per project (Colorado) to 1 per 2,000 cu. yd. (Nevada). Apparently, as was the case with respect to the final record sampling program, the extent of the progress program depends on the nature of the materials found in the various states and the agreements arrived at between the various State Highway Engineers and the Bureau Division Engineers involved.

In response to a question concerning apparent differences in the results of quality tests on progress and final record samplings, a majority of the states indicated noticeable amounts of degradation of aggregate base, subbase, and AC surfacing aggregate as reflected in the results of gradation, plasticity index, and sand equivalent tests. With respect to a question concerning changes resulting from the record sampling program, two states indicated an augmentation of control sampling. Apparently the greatest impact of this program has occurred in Nevada, which has initiated basic changes in their specification regarding "acceptance points" for aggregates as a result of the degradation which occurs as a result of handling and compaction of this material. Similar changes are indicated by the replies of Hawaii and Utah.

Progress Sampling Results in California

A tabulation of the results of progress and quality tests by the California Division of Highways for the calendar year 1963 is presented by Figures 13 through 16. As shown by Figure 13, the ogive curves for aggregate base sand equivalence indicate an average reduction in sand equivalence of 6 points between the progress and final record samples. 6.6% of the final record samples failed to meet the minimum sand equivalent requirement, as opposed to 2.3% of the progress samples. The effect of handling and compaction on aggregate subbase is even more pronounced

(Figure 14). Here, an average drop of 7 sand equivalent points between the progress and final phase is shown. 13.6% of the final samples failed to meet the minimum sand equivalent requirement, as opposed to 5.3% of the progress samples.

Even though there is a significant reduction in sand equivalence resulting from construction operations, this change is not reflected in the results of stability tests (Figures 15 and 16) on the same samples. Here, when one takes into consideration the reproducibility of tests, stabilities are the same. In fact, a slightly higher percentage of progress samples than final failed to meet the minimum R-value requirement.

Figures 17 through 19 show quality test results for individual projects in which a relatively large number of progress samples were taken.

For Project 63-W-28 (Figure 17), the average grading curves show an increase in percent passing the No. 200 sieve of 4% for the final, as compared to the progress samples. This change is reflected in a slight drop in sand equivalence (46 to 40), and only a 1 point loss in R-value (83 to 82). We may conclude from these results that the degradation which occurred was in the form of noncolloidal particles which had little effect on the quality of the material.

For Project 62W-103 (Figure 18), the aggregate subbase increased in percent passing the No. 200 sieve from 11 to 19% (average) although the final product was well within relatively wide aggregate subbase grading tolerances for this particular project. The results of this degradation are reflected in a reduction in sand equivalence of from 40 to 27 and a loss in R-value from 74 to 68. In this case, we can safely assume that the degradation which occurred was, in large part, colloidal or plastic in nature which had a significant effect on the stability of the material. This change is of technical interest only, however, since in the final form, the material is well above minimum specification requirements.

For Project 63W-74 (Figure 19), a 6% increase in percent passing the No. 200 sieve is reflected in a very sizeable reduction in sand equivalence of from 60 for the progress samples to 33 for the final samples. The stability, however, was not affected.

These early results of the progress record program very definitely show a significant amount of degradation as a result of the construction process in both base and subbase. The effect of this change varies in accordance with geologic composition of the aggregates concerned. In general, stability is not affected by the increase in fines within the ranges under consideration although there is probably a detrimental effect upon the drainage characteristics of the structural section. The fact that beyond certain limits, large changes in sand equivalence have no significant effect on the stability of base and subbase supports the recent revision in California's Standard Specifications eliminating a mandatory R-value test on base and subbase providing minimum sand equivalent and grading requirements are met for the control samples.

IV. Conclusions

The question as to whether the record sampling and testing program has been worth the several millions of dollars invested in it during its four years of operation in California is a matter of some conjecture. Undoubtedly, opinions will vary widely from state to state. Since, however, the program is with us for the foreseeable future due to unfortunate happenings in a few states, let us examine some of its tangible benefits.

It has given all of the states a large volume of construction and quality control data. While the statistical validity of the measurements may be open to some question, there can be little doubt that we now have a very useful tool for evaluation of highway construction. Certainly California, and probably other states, with limited exceptions, did not have any significant amount of final thickness data prior to the implementation of this program. Accumulation of this information has, therefore, resulted in a more realistic approach to thickness tolerances throughout the United States.

Another very tangible benefit has been the more direct involvement of state central laboratories in construction control, primarily through the progress testing program. This has given the younger construction engineer the benefit of the longer and more specialized experience of the materials engineer in the field of materials sampling and testing. In addition, comparisons of final record and progress and control quality test results has given us an insight into the prqblem of deterioration and degradation of materials due to construction operations and has, in some instances, resulted in specification changes on "acceptance parameters" for roadway materials.

Another beneficial effect of the program has been that of making construction and contractor personnel more materials conscious. The improvement in construction and quality control resulting from this, and the accelerated development of new construction equipment, has already been discussed.

In spite of the unfavorable circumstances which prompted its beginnings, it is most likely that many states would continue this program in some form even in the unlikely event that the requirement was withdrawn by the Bureau of Public Roads.

TABLE 1

SAMPLING AND TESTING

November 1963

MINIMUM NECESSARY

SIZE, FREQUENCY AND LOCATION OF SAMPLING AND TESTING

PORTLAND CEMENT CONCRETE --PAVEMENT--

MATERIAL OR PRODUCT		TEST FOR	TEST NO.	SIZE OF SAMPLE	INITIAL: LOCATION OR TIME OF SAMPLING	CONTROL: FREQUENCY OF SAMPLING	PROGRESS: LOCATION OR TIME OF SAMPLING	PROGRESS: FREQUENCY OF SAMPLING	FINAL: LOCATION OR TIME OF SAMPLING	FINAL: FREQUENCY OF SAMPLING	REMARKS
MINERAL AGGREGATE	COARSE AGGREGATE	LA Rattler (500 rev)	211	See Note (2) for Sample size for all Tests	See Note (1)						
MINERAL AGGREGATE	COARSE AGGREGATE	Cleanness Value	227		See Note (1)	2 times daily	Batch Bin-Just prior to mixing	1 for every 5 days of paving, min. of 3 per job.			Coarse aggr. only
MINERAL AGGREGATE	FINE AGGREGATE	Colormetric Test	213		See Note (1)	None unless initial test shows critical or contamination suspected.	Batch Bin-Just prior to mixing	Spot check-minimum of once a job			
MINERAL AGGREGATE	FINE AGGREGATE	Mortar Strength	515		See Note (1)						
MINERAL AGGREGATE	FINE AGGREGATE	Sand Equivalent	217		See Note (1)	2 times daily	Batch Bin-Just prior to mixing	1 for every 5 days of paving, minimum of 3 per job			
MINERAL AGGREGATE	COARSE & FINE AGGREGATE	Freeze-Thaw	528		See Note (1)						
MINERAL AGGREGATE	COARSE & FINE AGGREGATE	Soundness	214		See Note (1)						
MINERAL AGGREGATE	COARSE & FINE AGGREGATE	Sieve Analysis	202		See Note (1)	2 times daily	Batch Bin-Just prior to mixing	1 for every 5 days of paving; minimum of 3 per job			
MINERAL AGGREGATE	COARSE & FINE AGGREGATE	Specific Gravity & Absorption	206 & 207		See Note (1)	When aggregate changed	Batch Bin-Just prior to mixing				
MINERAL AGGREGATE	COARSE & FINE AGGREGATE	Moisture	223		None	As required for control min once a day	Batch Bin-Just prior to mixing				
CEMENT		Compliance with Std Specs. and Special Provisions	ASTM C 150	4 lb	None with certificate of compliance. (SEE REMARKS)	One sample for each 500 Barrels delivered or fraction thereof	From weigh hopper or screw leading to weigh hopper	Progress Sampler to observe method of sampling at least once during project			If no certificate of compliance, sample at least 7 days prior to use for previously tested brands; 28 days for untested brands
WATER		Compliance with Section 90 of Std Specs and Specl Prov.	405	1/2 Gallon	At point of use (SEE REMARKS)	As required for control (SEE REMARKS)	At point of use				City water supplies for domestic use usually need not be tested unless suspected of high chloride or sulphate content. On-the-job wells should be tested.
ADMIXTURES	Air entraining Agents	Air entraining Properties Chlorides Identification	415	1 Qt. can of liquid 2 lb powder	Samples must reach testing lab at least one week prior to use	As new supplies arrive on the job or each time brand is changed	Samples must reach testing lab at least one week prior to use.				
ADMIXTURES	Water Reducers Set Retarders	Claimed Properties Chlorides Identification	530 or 415	1 Qt. can of liquid 2 lb. powder	Samples must reach testing lab at least one week prior to use; untested brands require 5 weeks prior to use for tests.	As new supplies arrive on the jobs or each time brand is changed	Samples must reach testing lab at least one week prior to use; untested brands require 5 weeks prior to use for tests.				
CONCRETE		Yield, Cement Factor, & Unit Weight	518	See Test Method		Each 200 cu yds.	At point it is deposited on the grade	Witness 1 for every 5 days of paving.			
CONCRETE		Slump—Kelly Ball	520			When test specimens fabricated and when consistency questionable	At point it is deposited on the grade	Witness 1 for every 5 days of paving.			
CONCRETE		Modulus of Rupture	523	3 beams 6" x 6" x 34" each		1A, 1B, and 1C for each 750 CY. C sample is an extra	At point it is deposited on the grade	Witness 1 for every 5 days of paving			
CONCRETE		Entrained Air	504	Approx. 1/2 cu. ft.		Frequent enough to maintain control – Not less than once every 4 hours.	At point it is deposited on the grade	Witness 1 for every 5 days of paving			
CONCRETE		Coarse Agg. per C F. of Concrete	529			As required to assure uniformity of concrete See Std. Spec.-Sec. 90	1st and last 4th of batch.				
CONCRETE		Dimensions				As required for control	Slab Subgrade and finished pavement.		Completed Pavement	Each Lane Mile	5" Core for final sample
[illegible]		Compliance (See Std. Spec)	AASHO M148	1 Qt. (can)		One sample from each lot	From barrels of stock on the job at least 10 days prior to use.				Sample after thorough agitation

(1) From Material Site or Stockpile: – Sample 2 months prior to use (9 months prior to use if subject to Freezing and Thawing)

(2) 150# of 2½" x 1½" – 100# of 1½" x ¾" – 75# of ¾ x #4 – 75# of 1" x #4 – 75# of pea gravel – 75# of sand. This material for test numbers 211, 213, 214, 217, 202, 227, 515, 206, 207, 528

TABLE 2

SAMPLING AND TESTING

November 1963

PORTLAND CEMENT CONCRETE – BRIDGES & MAJOR STRUCTURES:
R.C.B. – P.C.C. Arch Culverts – Retain. Walls Slope Paving

MATERIAL OR PRODUCT		TEST FOR	TEST NO	SIZE OF SAMPLE	INITIAL	CONTROL / PROGRESS			FINAL		MINIMUM NECESSARY
					LOCATION OR TIME OF SAMPLING	FREQUENCY OF SAMPLING	LOCATION OR TIME OF SAMPLING	FREQUENCY OF SAMPLING	LOCATION OR TIME OF SAMPLING	FREQUENCY OF SAMPLING	REMARKS
MINERAL AGGREGATE	COARSE AGGREGATE	LA Rattler (500 rev.)	211	See Note (3)	See Note (2)						
MINERAL AGGREGATE	COARSE AGGREGATE	Cleanness Value	227	See Note (3)	See Note (2)	1 for approx. every 300 cu yds. of concrete (1) At least 1 per job	Batch Bin-Just prior to mixing	Approx. once for each 10 days of conc. production (1)			
MINERAL AGGREGATE	FINE AGGREGATE	Colometric Test	213	See Note (3)	See Note (2)	None unless initial test shows critical or contamination suspected.	Batch Bin-Just prior to mixing				
MINERAL AGGREGATE	FINE AGGREGATE	Mortar Strength	515	See Note (3)	See Note (2)						
MINERAL AGGREGATE	FINE AGGREGATE	Sand Equivalent	217	See Note (3)	See Note (2)	1 for approx. every 300 cu yds. of concrete (1) At least 1 per job	Batch Bin-Just prior to mixing	Approx once for each 10 days of conc. production (1)			
MINERAL AGGREGATE	COARSE & FINE AGGREGATE	Freeze Thaw	528	See Note (3)	See Note (2)						
MINERAL AGGREGATE	COARSE & FINE AGGREGATE	Soundness	214	See Note (3)	See Note (2)						
MINERAL AGGREGATE	COARSE & FINE AGGREGATE	Sieve Analysis	202	See Note (3)	See Note (2)	1 for approx every 300 cu. yds of concrete (1) At least 1 per job	Batch Bin-Just prior to mixing	Approx once for each 10 days of conc. production (1)			
MINERAL AGGREGATE	COARSE & FINE AGGREGATE	Specific Gravity & Absorption	206 & 207	See Note (3)	See Note (2)	When aggregate changed	See Note (2)				
MINERAL AGGREGATE	COARSE & FINE AGGREGATE	Moisture	223 or oven dry			As required for control	Batch Bin-Just prior to mixing				
CEMENT		Compliance with Std Specs. and Special Provisions	ASTM C150	4 lb	None with Cert. of Comp. (SEE REMARKS)	1 for approx every 300 cu. yds. of concrete (1) (See Const.Man. 8-02.06a)	Cement weigh hopper or screw leading to weigh hopper.	Witness sampling method at least once during project			If no certificate of compliance; sample at least 7 days prior to use for previously tested brands: 28 days for untested brands.
WATER		Compliance with Sec. 90 of Std Specs & Special Prov.	405	1/2 Gallon	At point of use (SEE REMARKS)	As required for control (SEE REMARKS)	At point of use				City water supplies for domestic use usually need not be tested unless suspected of high chloride or sulphate content. On-the-job wells should be tested.
ADMIXTURES	Air entraining Agents	Air entraining properties— Chlorides Identification	415	1 Qt. can of liquid 2 lb. powder	Samples must reach testing lab at least one week prior to use.	Each new lot of material brought to job.	Samples must reach testing lab at least one week prior to use				
ADMIXTURES	Water Reducers Set Retarders	Claimed properties Chlorides Identification	530 or 415	1 Qt. can of liquid 2 lb. powder	Samples must reach testing lab at least one week prior to use, untested brands require 5 weeks prior to use for tests.	Each new lot of material brought to job	Samples must reach testing lab at least one week prior to use; untested brands require 5 weeks prior to use for tests.				
CONCRETE		Yield, Cement Factor	518	Approx. 1 cu. ft.		1 for approx. every 600 cu. yds. of conc.—min of 2	At point concrete is deposited in the work	Witness test at least once per job			
CONCRETE		Slump-Kelly Ball	520			When test specimens fabricated and when consistency questionable	At point concrete is deposited in the work	Witness test procedure approx. once for every 1000 c.y. or fraction			
CONCRETE		Compressive Strength	521	3–6 x 12 test cylinders		1A, or 1B, and 1C only for approx. every 300 cu. yd. concrete or as required for control. Min. of 1 set per job	At point concrete is deposited in the work	Witness fabrication of test specimens once per job			
CONCRETE		Entrained Air	504			Approx. once every 4 hours or as required for control	At point concrete is deposited in the work	Witness test procedure approx. once for every 1000 c.y. or fraction thereof.			
CONCRETE		Coarse aggregate per C.F. of concrete	529			As required to assure uniformity of concrete	1st & last 1/4 of batch	Witness test method at least once during project			

(1) Not required if P.C.C. from same source is being used on other works and test is being made there. No need to duplicate the test, just for the sake of the record. The actual test results may be used anywhere they are applicable.
(2) From Material Site or Stockpile. Two months prior to use (Nine months prior to use if subject to Freezing & Thawing).
(3) 150# of 2½" x 1½" – 100# of 1½" x ¾" – 75# of 1" x No. 4 – 75# of ¾" x No. 4 – 75# of pea gravel – 75# of sand. This material for tests 211, 213, 214, 217, 202, 227, 515, 206, 207, 528

TABLE 3

SAMPLING AND TESTING

November 1963

PORTLAND CEMENT CONCRETE – MISCELLANEOUS CONCRETE
Minor Structures, Curbs, Gutters, Sidewalks, P.C.C. Foundations or Bases, Fence Posts

SIZE FREQUENCY AND LOCATION OF SAMPLING AND TESTING — MINIMUM NECESSARY

MATERIAL OR PRODUCT	TEST FOR	TEST NO	SIZE OF SAMPLE	INITIAL (1)	CONTROL / PROGRESS			FINAL		REMARKS
				LOCATION OR TIME OF SAMPLING	FREQUENCY OF SAMPLING	LOCATION OR TIME OF SAMPLING	FREQUENCY OF SAMPLING	LOCATION OR TIME OF SAMPLING	FREQUENCY OF SAMPLING	
MINERAL AGGREGATE – COARSE AGGREGATE	L.A. Rattler (500 rev.)	211	See Note (3)	See Note (4)						
MINERAL AGGREGATE – COARSE AGGREGATE	Cleanness Value	227	See Note (3)	See Note (4)	1 for each 100 cu. yds used; Min. of 1 per project (2)	Batch Bin-Just prior to Mixing				
MINERAL AGGREGATE – FINE AGGREGATE	Colorimetric Test	213	See Note (3)	See Note (4)	None unless initial test shows critical or contamination suspected	Batch Bin-Just prior to mixing				
MINERAL AGGREGATE – FINE AGGREGATE	Mortar Strength	515	See Note (3)	See Note (4)						
MINERAL AGGREGATE – FINE AGGREGATE	Sand Equivalent	217	See Note (3)	See Note (4)	1 for each 100 cu yds used, Min. of 1 per project (2)	Batch Bin-Just prior to mixing				
MINERAL AGGREGATE – COARSE & FINE AGGREGATE	Freeze Thaw	528	See Note (3)	See Note (4)						
MINERAL AGGREGATE – COARSE & FINE AGGREGATE	Soundness	214	See Note (3)	See Note (4)						
MINERAL AGGREGATE – COARSE & FINE AGGREGATE	Sieve Analysis	202	See Note (3)	See Note (4)	1 for each 100 cu yds used; Min. of 1 per project (2)	Batch Bin-Just prior to mixing				
MINERAL AGGREGATE – COARSE & FINE AGGREGATE	Specific Gravity & Absorption	206 & 207	See Note (3)	See Note (4)	When aggregate changed	See Note (4)				
MINERAL AGGREGATE – COARSE & FINE AGGREGATE	Moisture	223 or oven dry			As required for control	Batch Bin-Just prior to mixing				
CEMENT	Compliance with Std. Specs. and Special Provisions	ASTM C150	4 lb	None with certificate of compliance (SEE REMARKS)	Each 140 Bbls. delivered or fraction thereof (2) (See Const. Manual Secion 8-02.06a)	Cement weigh hopper or screw leading to weigh hopper or from sacks.				If no certificate of compliance, sample at least 7 days prior to use for previously tested brands; 28 days for untested brands.
WATER	Compliance with Sec. 90 of Std. Specs. & Special Prov.	405	1/2 Gallon	At point of use (SEE REMARKS)	As required for control (SEE REMARKS)	At point of use				City water supplies for domestic use usually need not be tested unless suspected of high chloride or sulphate content. On-the-job wells should be tested
ADMIXTURES – Air entraining agent	Air entraining properties–Chlorides Identification	415	1 Qt. can of liquid; 2 lb. powder	Samples must reach testing lab at least one week prior to use.	When new lots are to be used.	Samples must reach testing lab at least one week prior to use.				
ADMIXTURES – Water reducers Set Retarders	Claimed Properties Chlorides Identification	530 or 415	1 Qt. can of liquid; 2 lb. powder	Samples must reach testing lab at least one week prior to use; untested brands require 5 weeks prior to use for tests.	When new lots are to be used	Samples must reach testing lab at least one week prior to use; untested brands require 5 weeks prior to use for tests.				
COMBINED MIX	Yield, Cement Factor	518	Approx. 1 cu. ft.		1 only for each day when vol. exceeds 25 cu. yds. None if total days run less than 25 cu. yds. (2)	At point concrete is deposited in the work				
COMBINED MIX	Slump-Kelly Ball	520			When test specimens fabricated and when consistency questionable	At point concrete is deposited in the work				
COMBINED MIX	Compressive Strength	521	3-6" X 12" Test Cylinders		1A, or 1B, & 1C only for each day, when volume exceeds 25 c.y. (2) None if total days run less than 25 cu. yds.	At point concrete is deposited in the work				
COMBINED MIX	Entrained Air	504	Approx. ½ cu. ft.		As required for control	At point concrete is deposited in the work				

(1) If the material proposed for use on the project in question has recently been tested in connection with another project and is satisfactory, then refer to those recent test results to satisfy the preliminary test result requirement.
(2) Not required if P.C.C. from same source is being used on other works and test is being made there. No need to duplicate the test just for the sake of the record, the actual test results may be used anywhere they are applicable.
(3) 150# of 2½" x 1½" – 100# of 1½" x ¾" – 75# of 1" x No. 4 – 75# of ¾" x No. 4 – 75# of pea gravel – 75# of sand. This material for tests 211, 213, 214, 217, 202, 227, 515, 206, 207, 528.
(4) From Material Site or Stockpile: – Sample 2 months prior to use (9 months prior to use if subject to Freezing and Thawing)

TABLE 4

SAMPLING AND TESTING

November 1963

SIZE, FREQUENCY AND LOCATION OF SAMPLING AND TESTING

MINIMUM NECESSARY

MATERIAL OR PRODUCT	TEST FOR	TEST NO	SIZE OF SAMPLE	INITIAL: LOCATION OR TIME OF SAMPLING	CONTROL: FREQUENCY OF SAMPLING	CONTROL: LOCATION OR TIME OF SAMPLING	PROGRESS: FREQUENCY OF SAMPLING	FINAL: LOCATION OR TIME OF SAMPLING	FINAL: FREQUENCY OF SAMPLING	REMARKS
ASPHALT CONCRETE — MINERAL AGGREGATE PRIOR TO MIXING (1)	L A Rattler	211	Type "A" & "B" UNPROCESSED 250#	Materials Site, Stockpile or Plant Bins						Not made on Type C
	Specific Gravity (coarse & fine agg)	206 & 208		Materials Site, Stockpile or Plant Bins						
	CKE	303	PROCESSED 50# of each bin size	Materials Site, Stockpile or Plant Bins	As necessary to maintain control	Plant Bins prior to mixing				
	Stabilometer	304		Materials Site, Stockpile or Plant Bins						Not made on Open Graded
	Swell	305	**** ****	Materials Site, Stockpile or Plant Bins						
	Moist, Vapor Suscep	307	Type "C" UNPROCESSED	Materials Site, Stockpile or Plant Bins						
	Moisture	311	100# PROCESSED		As necessary for control	Plant Bins prior to mixing				
	% Crushed Particles	205	50#	Materials Site, Stockpile or Plant Bins						Not made on Type C
	Sieve Analysis	202	**** ****	Materials Site, Stockpile or Plant Bins	2 Times Daily	Plant Bins prior to mixing	1 progress for every 10 control-minimum of three			
	Sand Equivalent	217	Open Graded 50#	Materials Site, Stockpile or Plant Bins	2 Times Daily	Plant Bins prior to mixing	1 progress for every 10 control-minimum of three			Not made on Open Graded Asphalt Concrete
	Film Stripping	302		Materials Site, Stockpile or Plant Bins						Made on Open Graded Asphalt Concrete Only
COMMERCIAL FILLER	Grading Wash & dry ratio on #200	202	10#	Source	Not necessary if tested in initial stage, unless source is changed	Before Mixing				
	Surface Area	340		Source	Not necessary if tested in initial stage, unless source is changed.	Before Mixing				
	Specific Gravity	208		Source	Not necessary if tested in initial stage, unless source is changed	Before Mixing				
Paving Asphalt Liquid Asphalt Asphaltic Em	In accordance with applicable Section of Std Specs		Asphalts 1 Qt	Test only if no certificate of compliance Plant Line.	Once daily	Plant line				
			Emulsion ½ Gal	Test only if no certificate of compliance Plant Storage Tank	Each Shipment	Plant Storage Tank or Distributor				
COMPLETE MIXTURE	Swell	305	15# Carton		As necessary for control	At point of delivery to street				Test as necessary for mix design control.
	Moist, Vapor Suscep.	307			As necessary for control	At point of delivery to street				Test as necessary for mix design control
	Extraction and Moisture	310			Daily Sample for approx each 1000 tons or fraction thereof. Not more than 2 Daily	At point of delivery to street	Witness approx. 1 in every 10 control samples	Completed Pav't	1 per Lane Mile	Test as necessary for mix design control. Final samples for informational purposes
	Sieve Analysis	202			Daily Sample for approx each 1000 tons or fraction thereof. Not more than 2 Daily	At point of delivery to street	Witness approx 1 in every 10 control samples.	Completed Pav't.	1 per Lane Mile	Test as necessary for mix design control Final samples for informational purposes
	Stabilometer	304			Daily Sample for approx each 1000 tons or fraction thereof. Not more than 2 Daily.	At point of delivery to Street	Witness approx 1 in every 10 control samples.			Test as necessary for mix design control
	Dimensions				As necessary for control	Completed Pav't.		Completed Pav't.	1 per Lane Mile	

(1) On smaller projects being supplied from sources currently in use on larger projects, a copy of the control test information on A.C. aggregate is all that is required.

TABLE 5

SAMPLING AND TESTING

November 1963

SIZE, FREQUENCY AND LOCATION OF SAMPLING AND TESTING

MINIMUM NECESSARY

MATERIAL OR PRODUCT	TEST FOR	TEST NO.	SIZE OF SAMPLE	INITIAL: LOCATION OR TIME OF SAMPLING	CONTROL: FREQUENCY OF SAMPLING	CONTROL: LOCATION OR TIME OF SAMPLING	PROGRESS: FREQUENCY OF SAMPLING	FINAL: LOCATION OR TIME OF SAMPLING	FINAL: FREQUENCY OF SAMPLING	REMARKS
AGGREGATE BASE	% Crushed Particles	205	100 lbs	Mat'l. Site or Stockpile (2)	Every 3000 tons or 2000 C.Y. (1)	At the time it is deposited on the roadbed				
AGGREGATE BASE	Sieve Analysis	202	100 lbs	Mat'l. Site or Stockpile (2)	Every 3000 tons or 2000 C.Y. (1)	At the time it is deposited on the roadbed	Approx. 1 in 10 control tests; minimum of three	Completed layer	1 per lane mile	Final Sample 40–60# Sack for informational purpose.
AGGREGATE BASE	Durability Index	229	100 lbs	Mat'l. Site or Stockpile (2)	If initial source changes or new source developed.	Material site or stockpile.				
AGGREGATE BASE	R-Value	301	100 lbs	Mat'l. Site or Stockpile (2)	Every 3000 tons or 2000 C.Y. (1) (See Std. Specs.)	At the time it is deposited on the roadbed	Approx. 1 in 10 control tests; minimum of three	Completed layer	1 per lane mile	Final Sample 40–60# Sack for informational purpose.
AGGREGATE BASE	Sand Equivalent	217	100 lbs	Mat'l. Site or Stockpile (2)	Every 3000 tons or 2000 C.Y. (1)	At the time it is deposited on the roadbed	Approx. 1 in 10 control tests; minimum of three	Completed layer	1 per lane mile	Final Sample 40–60# Sack for informational purpose.
AGGREGATE BASE	Moisture	216			2 Times Daily	At time of weighing				
AGGREGATE BASE	Relative Compaction	216	30 lbs		As necessary for control	In place after compaction	Witness at least once for each job			
AGGREGATE BASE	Grade Tolerance				As necessary for control	Upon completion of layer		As layer is completed and before it is covered up	1 per lane mile	
CEMENT TREATED BASE, Road Mix or Plant Mix — MINERAL AGGREGATE	R-Value (with & without cement)	301	100 lbs	Mat'l Site or Stockpile						Class C
CEMENT TREATED BASE — MINERAL AGGREGATE	Compressive Strength	312	100 lbs	Mat'l. Site or Stockpile						Class A & B
CEMENT TREATED BASE — MINERAL AGGREGATE	Sieve Analysis	202	100 lbs	Mat'l Site or Stockpile	1 sample for each 3000 tons (1)	Prior to mixing				Class A, B, & C
CEMENT TREATED BASE — MINERAL AGGREGATE	Lump Disintegration	201	100 lbs	Mat'l. Site or Stockpile						
CEMENT TREATED BASE — MINERAL AGGREGATE	Sand Equivalent	217	100 lbs	Mat'l Site or Stockpile	1 sample for each 3000 tons (1)	Prior to mixing				Class A, B, & C
CEMENT TREATED BASE — COMPLETED MIX	Compressive Strength	312		Mat'l Site or Stockpile	1 sample for each 3000 tons (1)	Mixed but uncompacted material	Witness fabrication at least once for each job			Class A & B
CEMENT TREATED BASE — COMPLETED MIX	R-Value	301			1 sample for each 3000 tons (1)	At point of delivery to grade				Class C
CEMENT TREATED BASE — COMPLETED MIX	Density	312			As necessary for control	In place after compaction	Witness at least once for each job			Class A & B
CEMENT TREATED BASE — COMPLETED MIX	Cement Titration	338			As necessary for control	At point of delivery to grade or after mixing				
CEMENT TREATED BASE — COMPLETED MIX	Relative Compaction	216			1 sample for each 3000 tons (1)	In place after compaction	Witness at least once for each job			Class C & D
CEMENT TREATED BASE — COMPLETED MIX	Thickness				As necessary for control	In place after compaction		As layer is completed and before it is covered up	1 per lane mile	
CEMENT	Compliance with Section 90 of Std. Specs and Special Provisions		4 lb	None with certificate of compliance (SEE REMARKS)	Each 400 Bbls delivered or fraction thereof	Weigh hopper or screw leading to weigh hopper or from distributor if road-mixed				If no certificate of compliance; sample at least 7 days prior to use for previously tested brands; 28 days for untested brands.
WATER	Compliance with Section 90 of Std. Specs.		1/2 to 1 Gallon	At point of use (SEE REMARKS)	As required for control (SEE REMARKS)	At point of use				No sample necessary if from obviously suitable source, such as municipal water supply. On-the-job wells should be tested.
LIQUID ASPHALT	In accordance with Special Prov & Std Specs.		1 Qt	None with Cert. of comp. If no cert. of comp. then from storage tank or distributor truck	Each Shipment	Distributor Truck				

(1) If material is uniform and well within specification limits the frequency may be decreased to one a day unless source is changed.
(2) If source is being used on another concurrent project, a copy of the initial qualifying test results used for that project may be used as long as the source or material has not changed

TABLE 6

SAMPLING AND TESTING

November 1963

SIZE, FREQUENCY AND LOCATION OF SAMPLING AND TESTING — MINIMUM NECESSARY

MATERIAL OR PRODUCT	TEST FOR	TEST NO	SIZE OF SAMPLE	INITIAL: LOCATION OR TIME OF SAMPLING	CONTROL: FREQUENCY OF SAMPLING	PROGRESS: LOCATION OR TIME OF SAMPLING	PROGRESS: FREQUENCY OF SAMPLING	FINAL: LOCATION OR TIME OF SAMPLING	FINAL: FREQUENCY OF SAMPLING	REMARKS
IMPORTED BORROW	Relative Compaction	216			As Required for Control	Immediately after material placed and compacted	Witness by spot check at least once per job			
BASEMENT SOIL	R-Value	301	50#	Excavation-if not previously checked for design purposes	As required to determine adequacy of cover	Grading Plane				
BASEMENT SOIL	Relative Compaction	216			As necessary for control	Immediately prior to placement of cover material				
BASEMENT SOIL	Grade Tolerance				As necessary for control	Grading Plane				
AGGREGATE SUBBASE	Sieve Analysis	202	50#	Mat'ls. Site or Stockpile	One for every 3000 tons or 2000 cu. yds. (1)	At point of delivery to grade	Approx. 1 in 10 control tests; minimum of three	Completed layer	1 per Lane-Mile	Final samples for informational purposes.
AGGREGATE SUBBASE	R-Value	301	50#	Mat'ls. Site or Stockpile	One for every 3000 tons or 2000 cu. yds. (1)	At point of delivery to grade	Approx. 1 in 10 control tests; minimum of three	Completed layer	1 per Lane-Mile	On Class 1 & 2 only—Final Samples for informational purposes
AGGREGATE SUBBASE	Sand Equivalent	217	50#	Mat'ls Site or Stockpile	One for every 3000 tons or 2000 cu. yds. (1)	At point of delivery to grade	Approx. 1 in 10 control tests, minimum of three	Completed layer	1 per Lane-Mile	On Class 1 & 2 only —Final Samples for informational purposes.
AGGREGATE SUBBASE	Relative Compaction	216			As necessary for control	In place after compaction	Witness by spot check at least once per job			
AGGREGATE SUBBASE	Grade Tolerance				As necessary for control	Upon completion of layer		Each individual stage as layer is completed and before it is covered up	1 per Lane-Mile	
ROAD - MIXED ASPHALT SURFACING: MINERAL AGGREGATE	Specific Gravity Coarse & Fine Agg.	206 & 208	100# for all tests	Mat'ls, Site or Stockpile						
ROAD - MIXED ASPHALT SURFACING: MINERAL AGGREGATE	Stabilometer	304	100# for all tests	Mat'ls. Site or Stockpile						
ROAD - MIXED ASPHALT SURFACING: MINERAL AGGREGATE	C. K. E.	303	100# for all tests	Mat'ls Site or Stockpile	1 per Windrow mile	Windrow				
ROAD - MIXED ASPHALT SURFACING: MINERAL AGGREGATE	Swell	305	100# for all tests	Mat'ls. Site or Stockpile						
ROAD - MIXED ASPHALT SURFACING: MINERAL AGGREGATE	Moist. Vap, Suscep.	307	100# for all tests	Mat'ls. Site or Stockpile	As required for control					
ROAD - MIXED ASPHALT SURFACING: MINERAL AGGREGATE	Sieve Analysis	202	100# for all tests	Mat'ls. Site or Stockpile	1 per lane mile	Windrow before mixing	1 for every 10 control minimum of three			
ROAD - MIXED ASPHALT SURFACING: MINERAL AGGREGATE	Sand Equivalent	217	100# for all tests	Mat'ls. Site or Stockpile	1 per lane mile	Windrow before mixing	1 for every 10 control minimum of three			
ROAD - MIXED ASPHALT SURFACING: MINERAL AGGREGATE	Moisture	310 or 311	100# for all tests	Mat'ls Site or Stockpile	As required for control	Windrow before mixing				
ROAD - MIXED ASPHALT SURFACING: MINERAL AGGREGATE	Disintegration Test	Std Spec.	100# for all tests	Mat'ls Site or Stockpile						
ROAD - MIXED ASPHALT SURFACING: COMPLETED MIXTURE	Stabilometer	304	15# Carton		Once Daily	Completed Mix				
ROAD - MIXED ASPHALT SURFACING: COMPLETED MIXTURE	M. V. S.	307	15# Carton		Once Daily	Completed Mix				
ROAD - MIXED ASPHALT SURFACING: COMPLETED MIXTURE	Swell	305	15# Carton		Once Daily	Completed Mix				
ROAD - MIXED ASPHALT SURFACING: COMPLETED MIXTURE	Extraction	310	15# Carton		Once Daily	Completed Mix				
ROAD - MIXED ASPHALT SURFACING: COMPLETED MIXTURE	Sieve Analysis	202	15# Carton		Once Daily	Completed Mix				
ROAD - MIXED ASPHALT SURFACING: COMPLETED MIXTURE	Moisture	310	15# Carton		Once Daily	Completed Mix				
ROAD - MIXED ASPHALT SURFACING: COMPLETED MIXTURE	Thickness				As necessary for control	Completed Layer		Completed Layer	1 per Lane-Mile	
ROAD - MIXED ASPHALT SURFACING: LIQUID ASPHALT	In Accordance with applicable Section of Std. Specs and/or Special Provisions		1 Qt.	None with certificate of compliance. If no cert. of comp. then from storage tank or distributor.	Each Shipment	Storage Tank or Distributor				

(1) If material is uniform and well within specification limits the frequency may be decreased to one a day unless source is changed.

TABLE 7

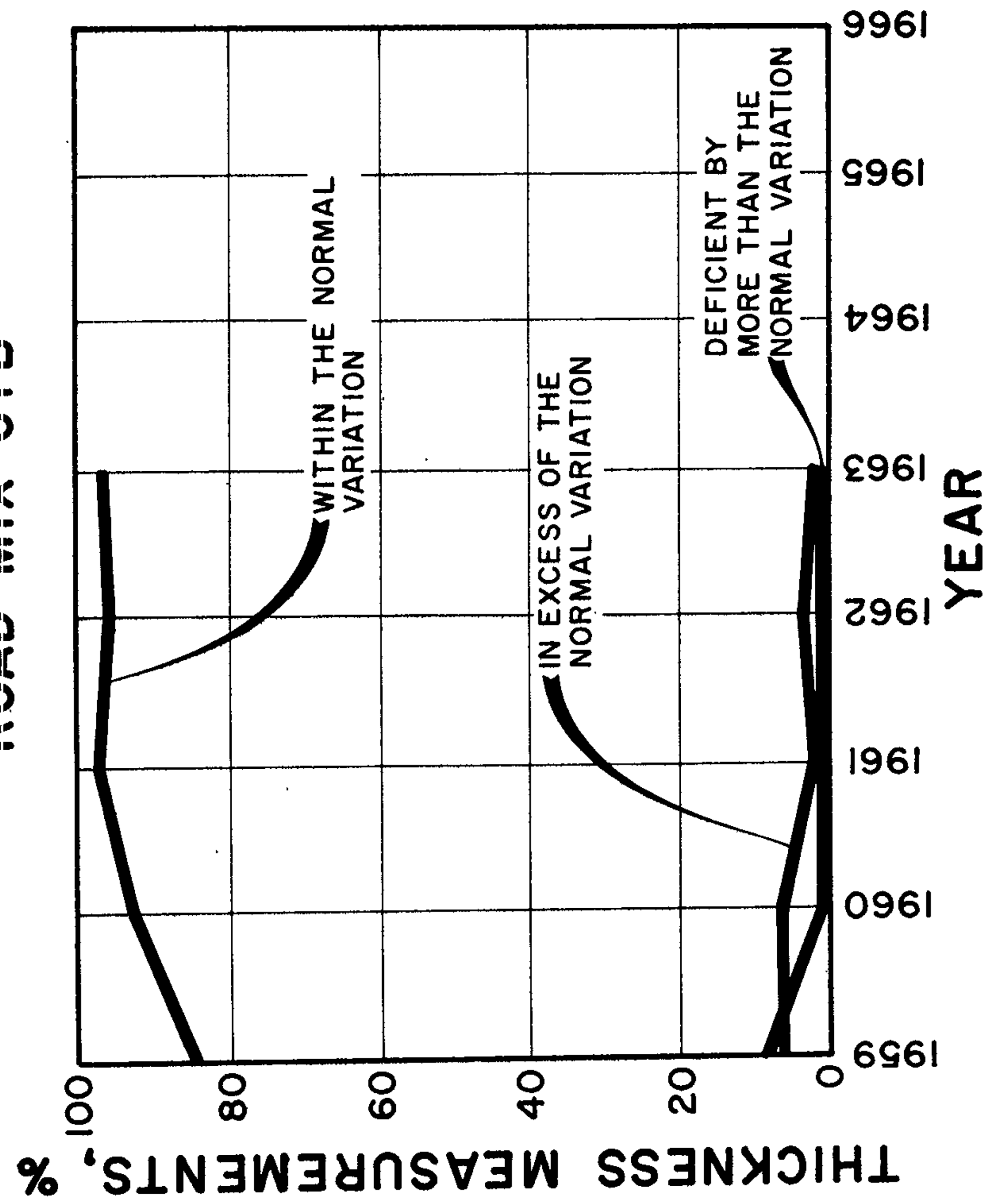
SUMMARY OF PROGRESS SAMPLING AND TESTING PROCEDURES FOR EIGHT WESTERN STATES

State	SAMPLING LOCATION AND FREQUENCY								Have any significant differences been noted between progress and final test results?	If so, what properties reflect the greatest change?	Have any changes in specification been initiated as a result of record testing?
	Agg. Base	Agg. Subbase	C.T.B.	Asphalt	A.C. Agg.	A.C. (Mix)	P.C.C Agg	Portland Cement Concrete			
California	At time of depositing on road bed 1 per 10 control min. of 3	At point of delivery to project 1 per 10 control min. of 3	Witness sampling and fabrication of specimens min. 1 per job	- - -	Plant bins prior to mixing 1 per 10 control	Witness 1 per 10 control samples	Batch bin prior to mixing 1 each 5 days min. 3 per job	Witness 1 for each 5 days of paving	Yes	Aggregate Base & Aggregate Subbase change in grading and sand equivalent	Yes - modification of thickness tolerances in revised (1964) standard specifications
Colorado	Windrows, Roadway[1] 1 per 4 lane mi.	Roadway[1] 1 per 4 lane mi.	Roadway[1] 1 per 4 lane mi.	Truck, storage tank - one per project	- - -	Pug mill, paver 1 per 4 lane mi.	Plant bin, stock pile 1 per project	Truck, paver 1 per 10 lane mi.	Yes, at times	Disintegrated granite, soft limestone, some sandstone. Increase in % passing No. 14, 10 and 200 sieve.	No
Idaho	Conveyer belt 1 per 25000 tons not less than 1 per 4 lane mi. or 2 per job.	Same as Agg. Base	Same as Agg. Base	- - -	- - -	- - -	- - -	- -	No	- - -	The % maximum density specification for Agg. Base was derived by record sampling tests.
New Mexico	- - -	- - -	- - -	Truck 1 per type per project	- - -	Paver 1 per 4 lane mi.	Stockpile 1 ea. of F A. and C.A. per source per project	Roadway[1] 1 per 4 lane mi.	No	- - -	Yes - have increased job control testing
Oregon	Windrow, plant bin, roadway[1] at random	Same as Base	- - -	Truck, paving plant at random	Plant bin, crusher at random	Truck, paver at random	Plant bin, batch plant at random	Truck on delivery occasional only	Yes	Slight difference in asphalt content. Minor degradation in softer aggregates	Yes - changes in acceptance points for aggregates. Construction control has been reinforced.
Nevada	Processed windrows min. 1 per 10,000 tons	Same as Base	Truck at loading point or spreader titration[2], 12 per day, compr strength, 2 per day	- - -	Stockpile occasionally	Back of paver 1 per 5,000 tons	Stockpile 1 per 2,000 C.Y.	Truck on delivery 1 per project	Yes	Untreated Base and A C. Aggregate show changes in gradation, sand equivalent, and plasticity index.	No - changes in properties were already anticipated in previous specifications.
Hawaii	Roadway[1] 1 per 10 Control Samples	Same as Base	- - -	Storage tank 2 per project	Plant bins, stockpile 1 per month	Truck on delivery 1 per day of paving	Plant bins, stockpile or conveyer belt 1 per month	Truck upon delivery As requested by B.P.R.	No significant difference except in Agg. Base & Subbase.	Degradation of -200 matl.	Yes - specifications for Surface, Base & Subbase Agg. were changed to give tighter control of gradation.
Utah	Roadway prior to compaction Occasionally in windrows 1 per lane mi.	Same as Base	Plant bins and roadway prior to compaction. 1 per lane mi.	Truck upon delivery, plant storage tank & as requested by Area Eng'r.	Plant bins 1 per 2 lane mi. or more	Plant bins, truck upon delivery, behind paver, cores from roadway after construction. 1 per 2 lane mi. or more	Plant bins & stockpiles. As requested by Area Eng'r.				

1 Prior to compaction
2 No distinction made between control and progress record sampling and testing

FIGURE 1

FINAL RECORD SAMPLING
THICKNESS DATA
ROAD MIX CTB



FINAL RECORD SAMPLING THICKNESS DATA

PLANT MIXED CTB

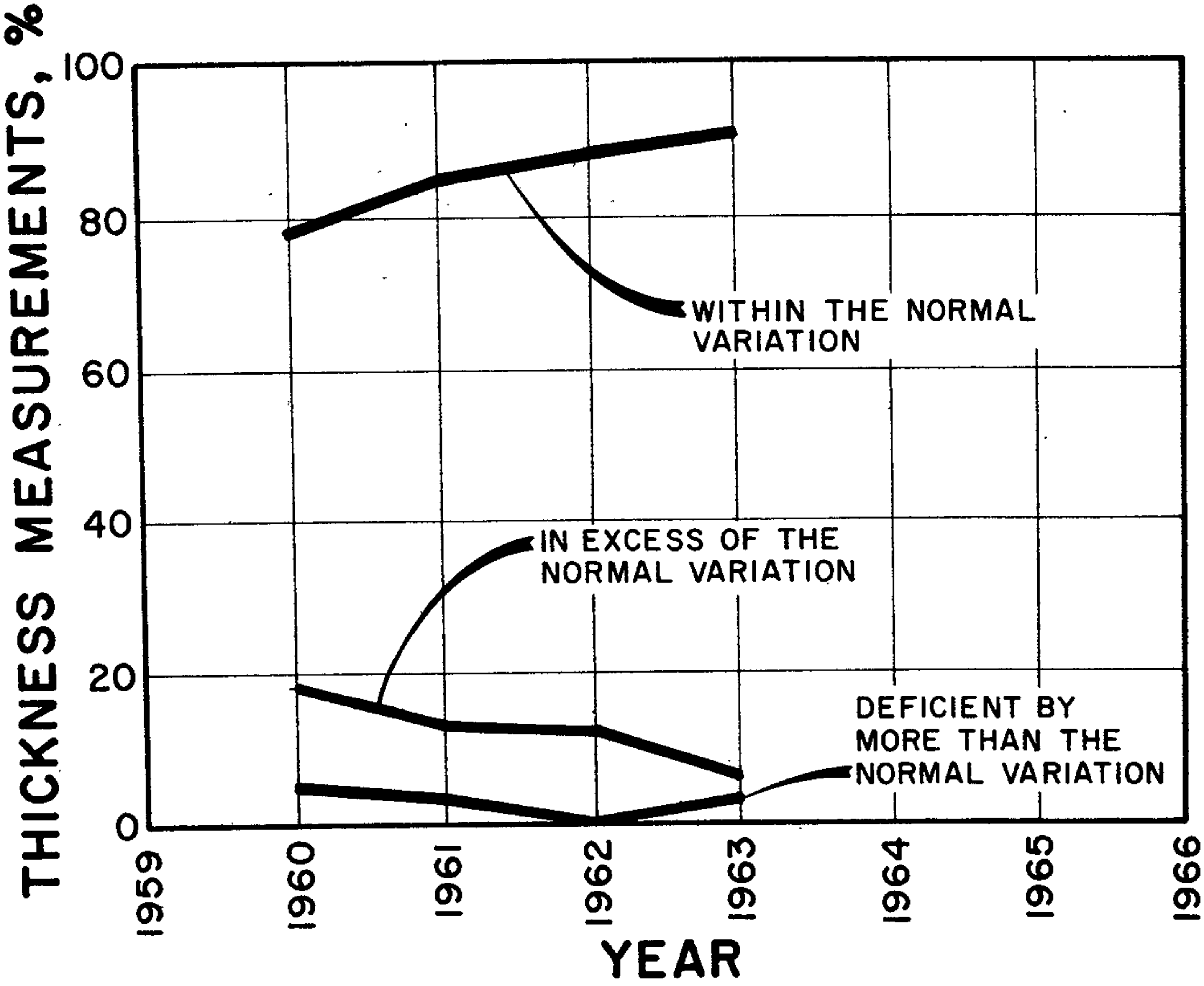


FIGURE 2

FIGURE 3

FINAL RECORD SAMPLING
THICKNESS DATA
ASPHALT CONCRETE

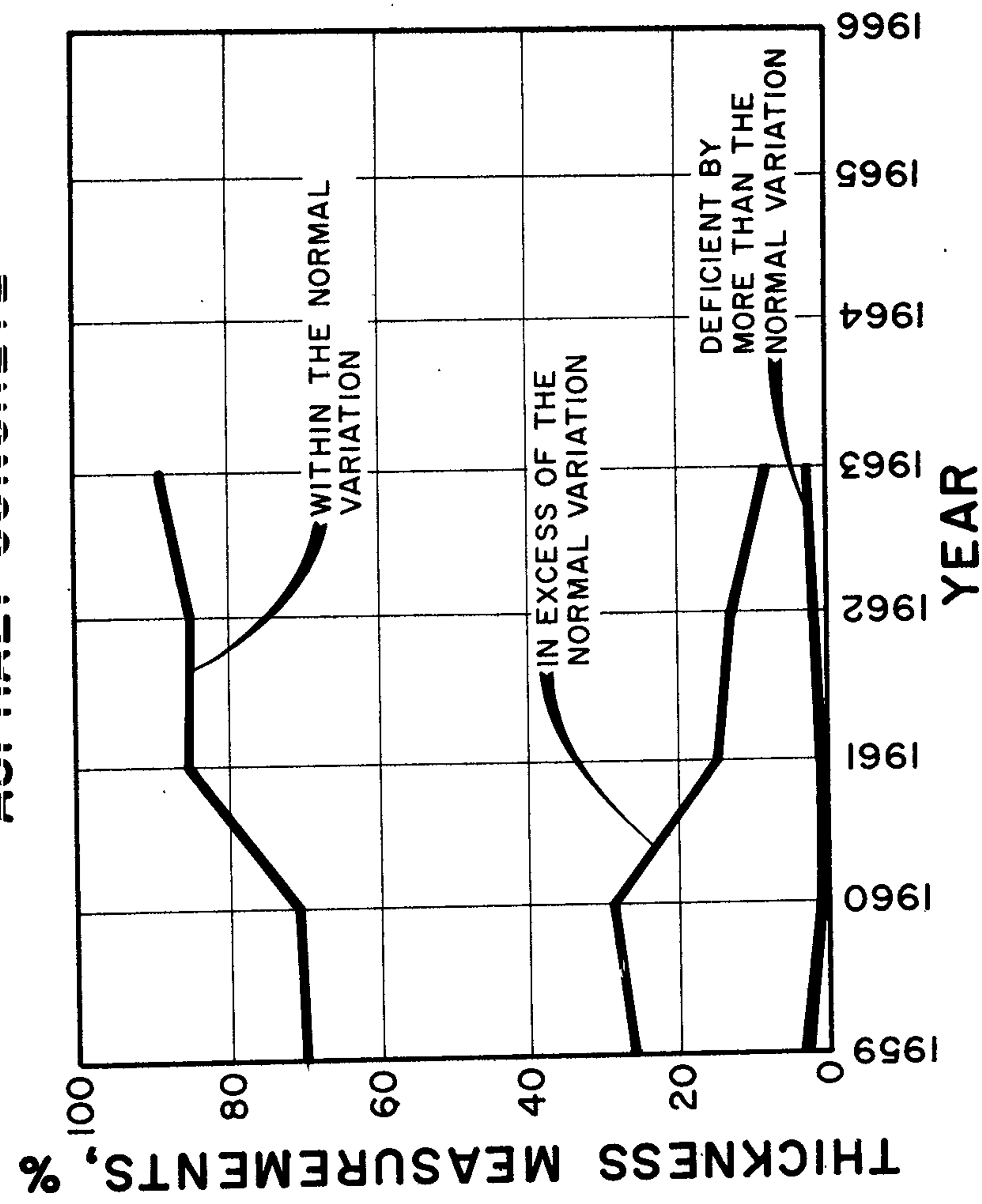
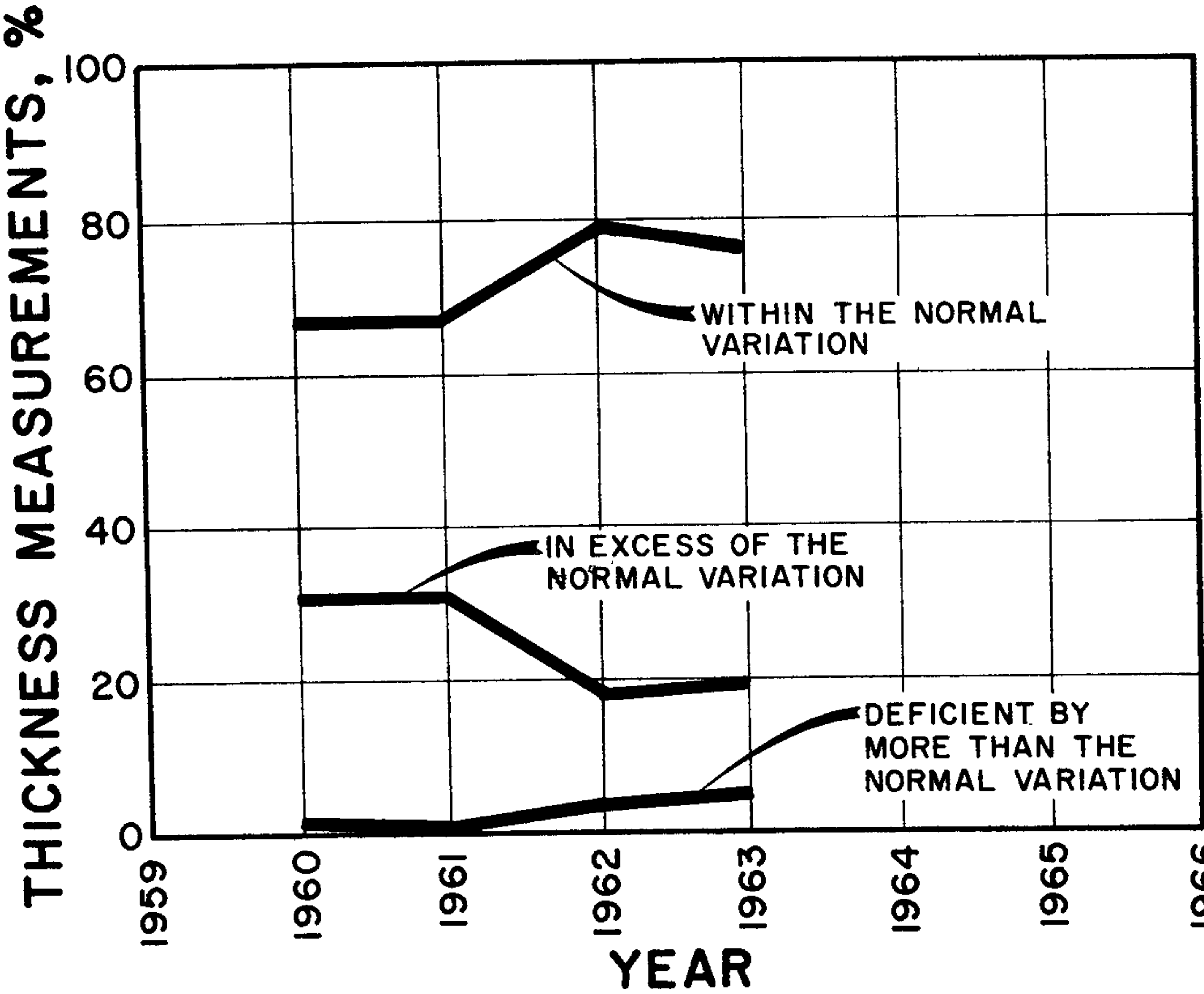


FIGURE 4

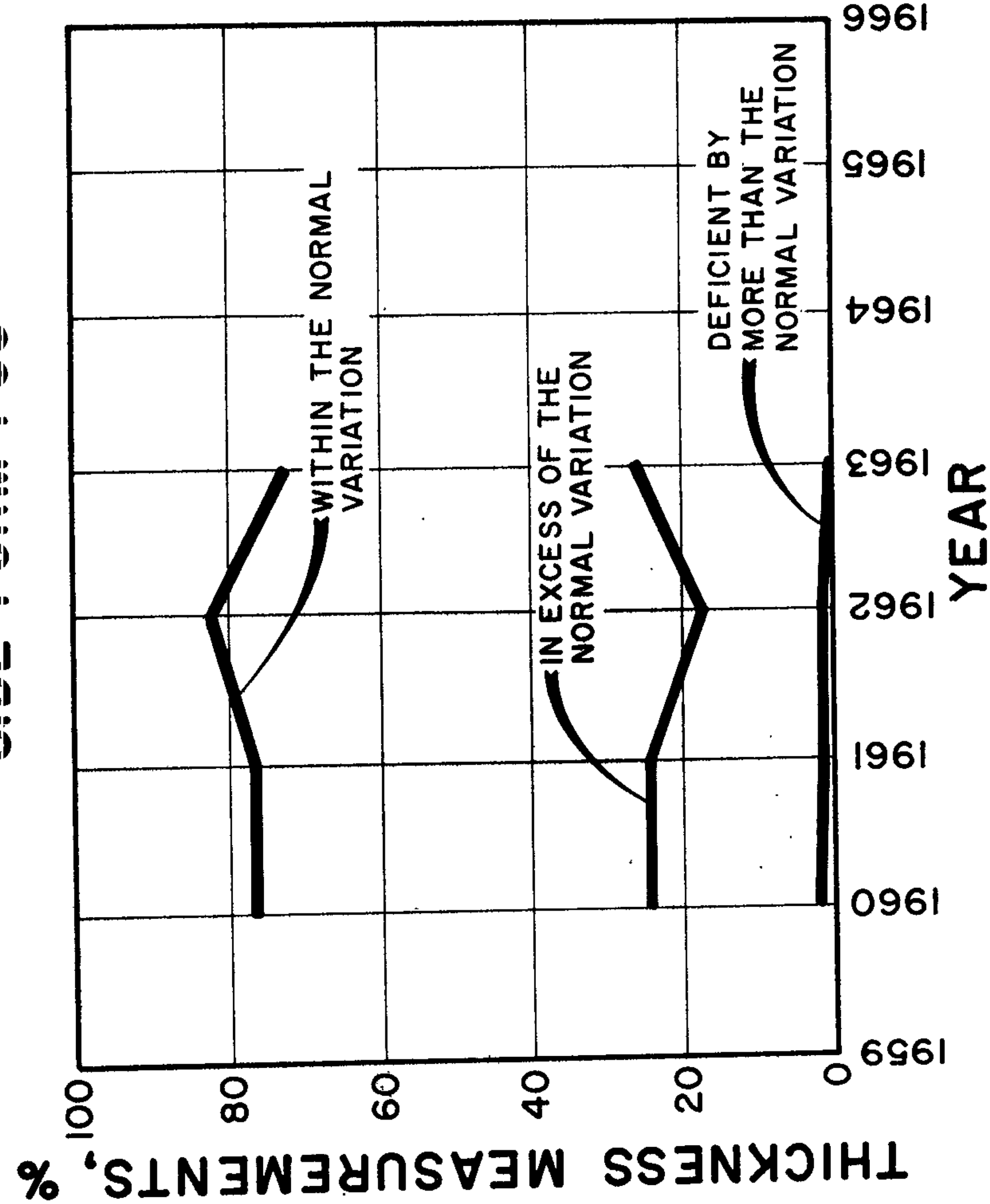
FINAL RECORD SAMPLING THICKNESS DATA

SLIP FORM PCC



FINAL RECORD SAMPLING THICKNESS DATA

SIDE FORM PCC



FINAL RECORD SAMPLING THICKNESS DATA
AGGREGATE BASE

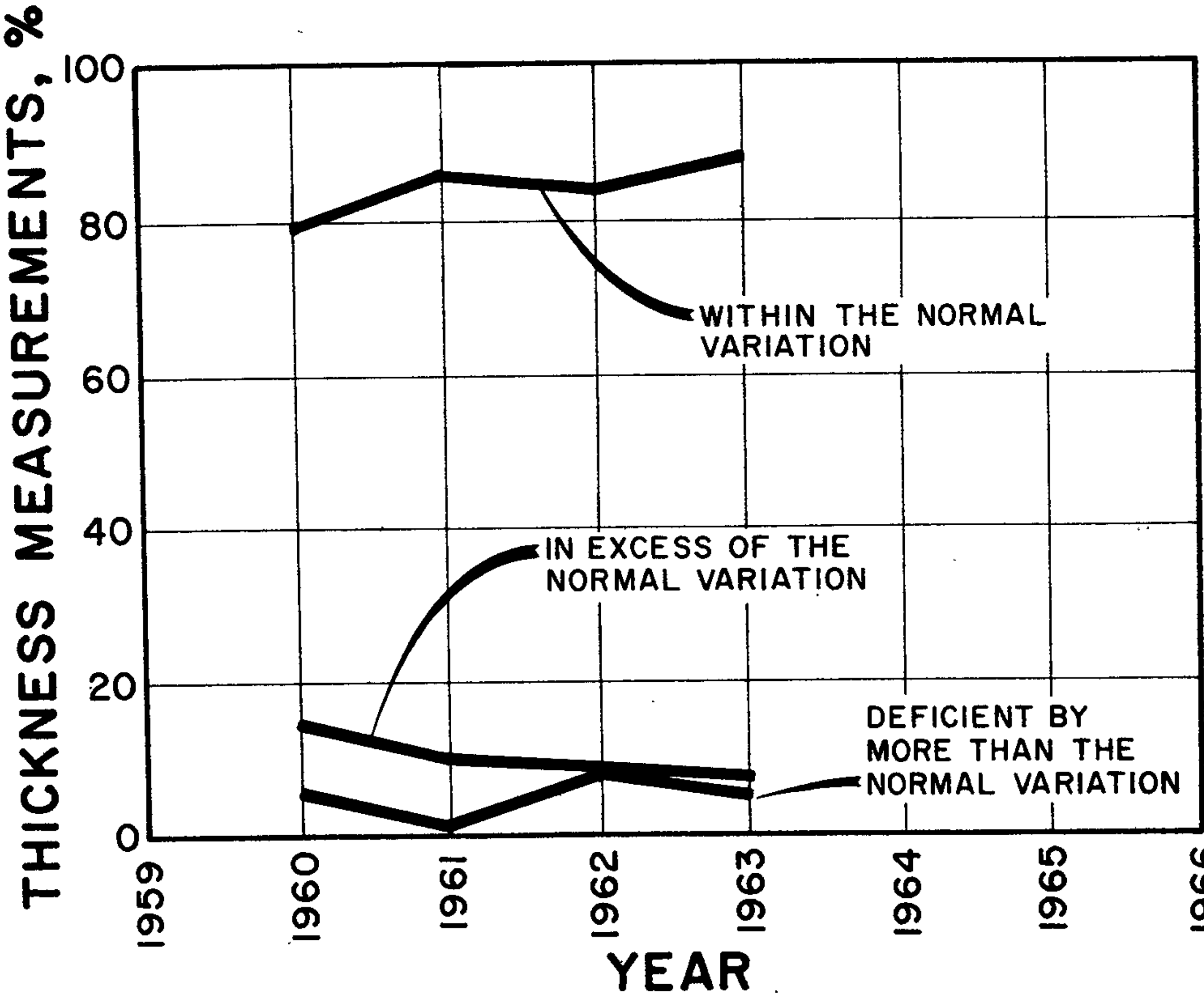


FIGURE 7

FINAL RECORD SAMPLING THICKNESS DATA AGGREGATE SUBBASE

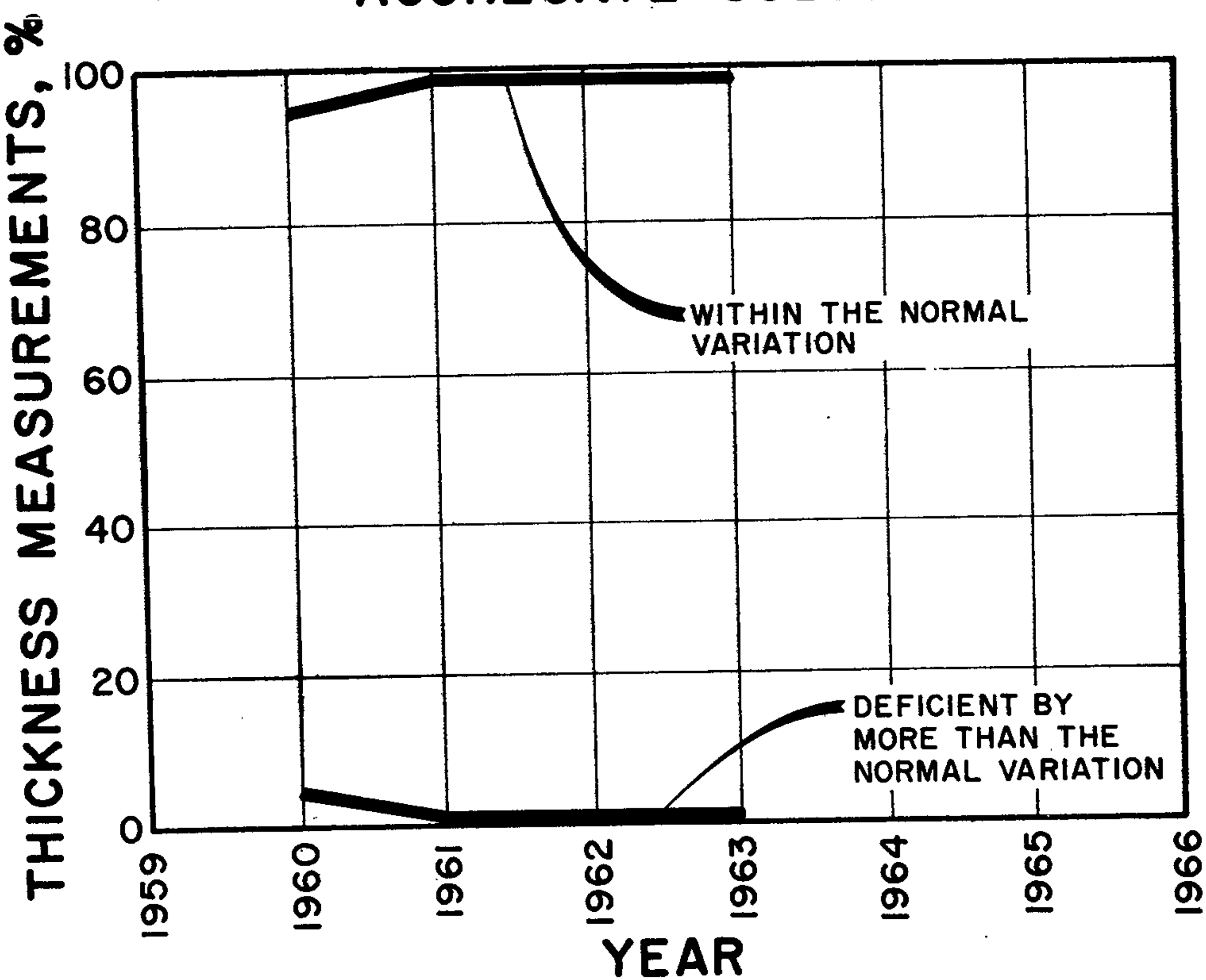


FIGURE 8

CALIFORNIA DIVISION OF HIGHWAYS RECORD SAMPLING DATA

OGIVE CURVES FOR THICKNESS MEASUREMENTS OF AGGREGATE SUBBASE

1960, 1963 and AASHO ROAD TEST

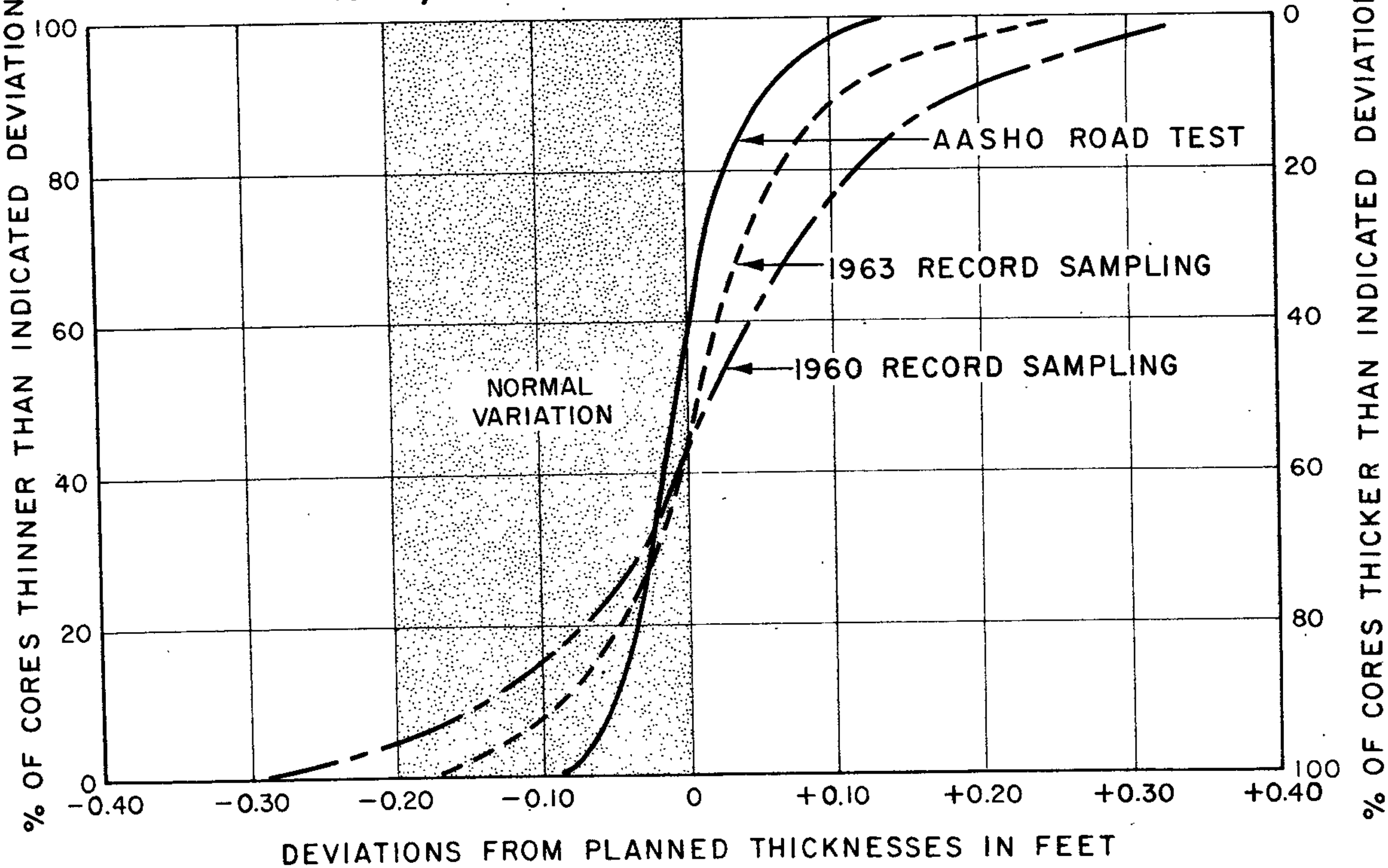


FIGURE 9

CALIFORNIA DIVISION OF HIGHWAYS RECORD SAMPLING DATA

OGIVE CURVES FOR THICKNESS MEASUREMENTS OF AGGREGATE BASE

1960, 1963 and AASHO ROAD TEST

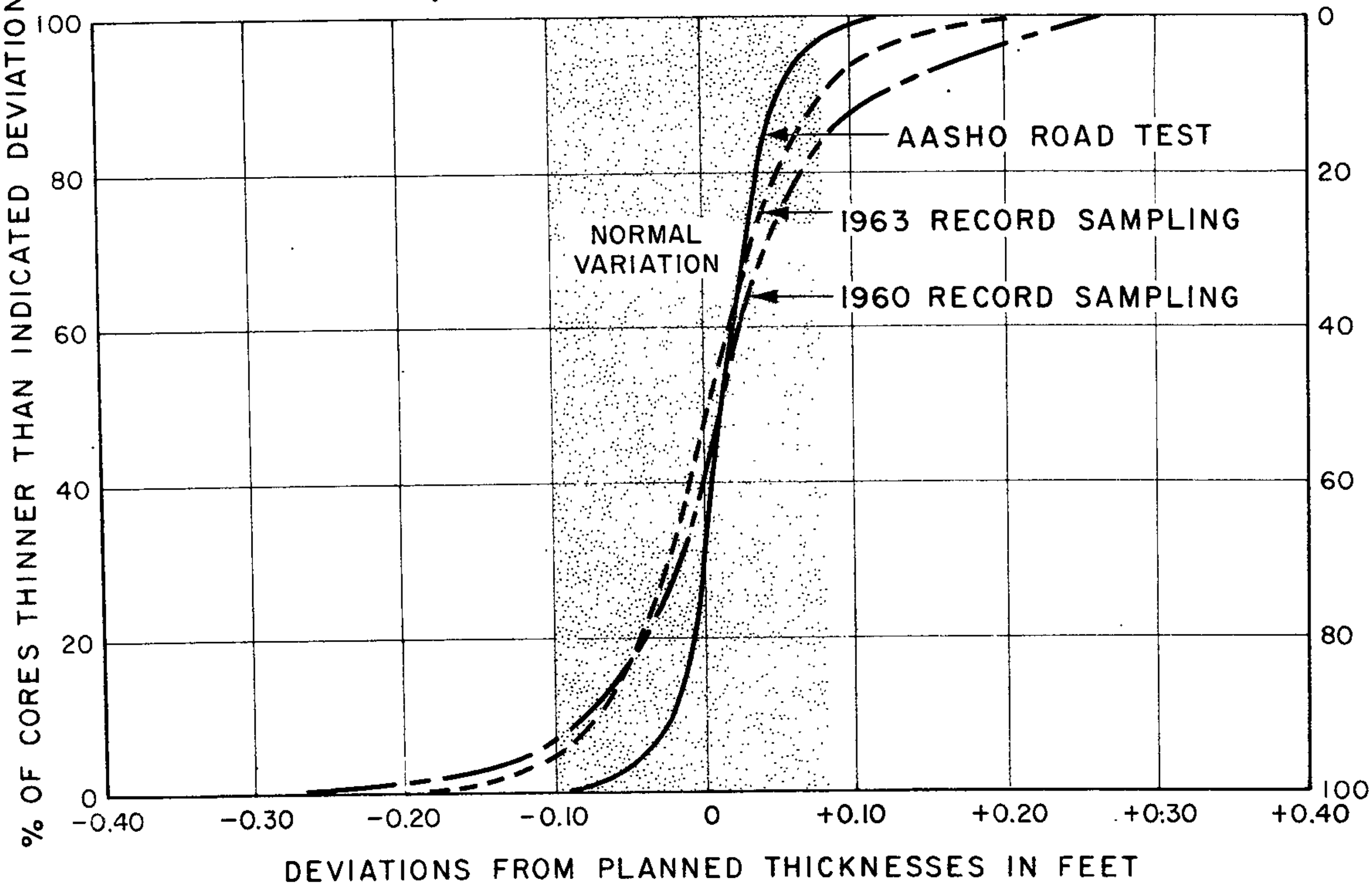


FIGURE 10

CALIFORNIA DIVISION OF HIGHWAYS RECORD SAMPLING DATA

OGIVE CURVES FOR THICKNESS MEASUREMENTS OF ASPHALT CONCRETE

1960, 1963 and AASHO ROAD TEST

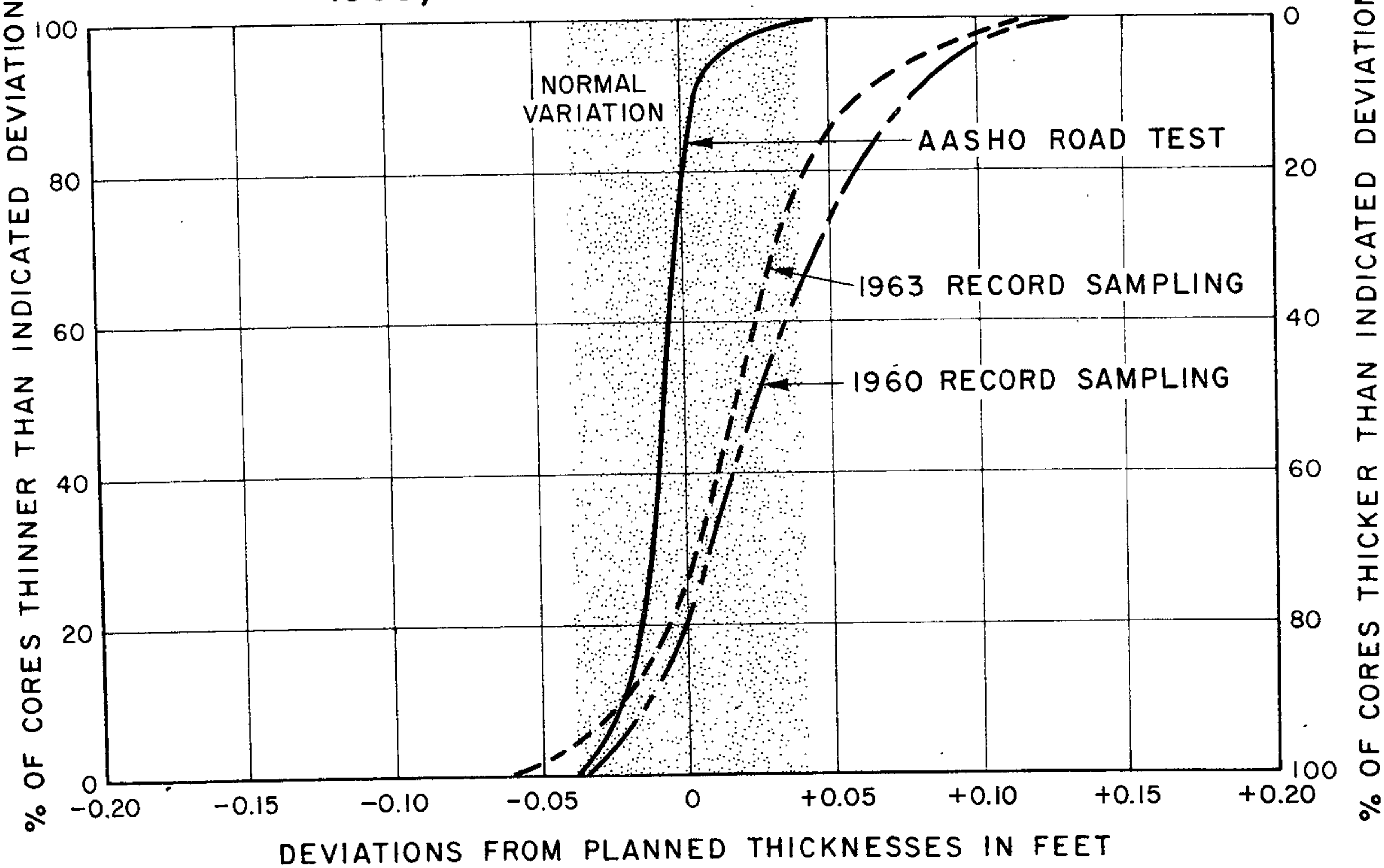
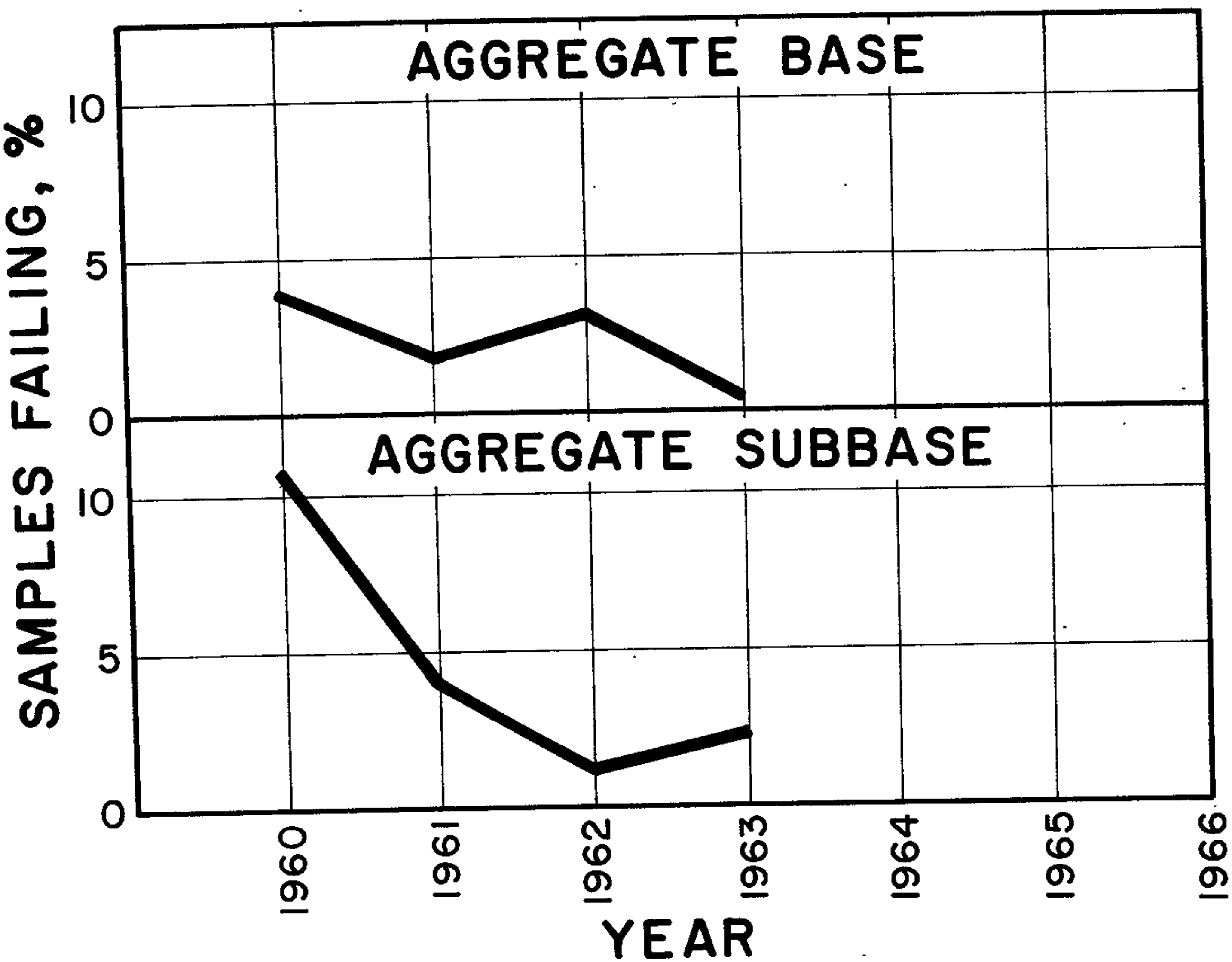


FIGURE 11

PERCENTAGE OF SAMPLES FAILING TO MEET "R" VALUE REQUIREMENT



PERCENTAGE OF SAMPLES FAILING TO MEET S.E. REQUIREMENT

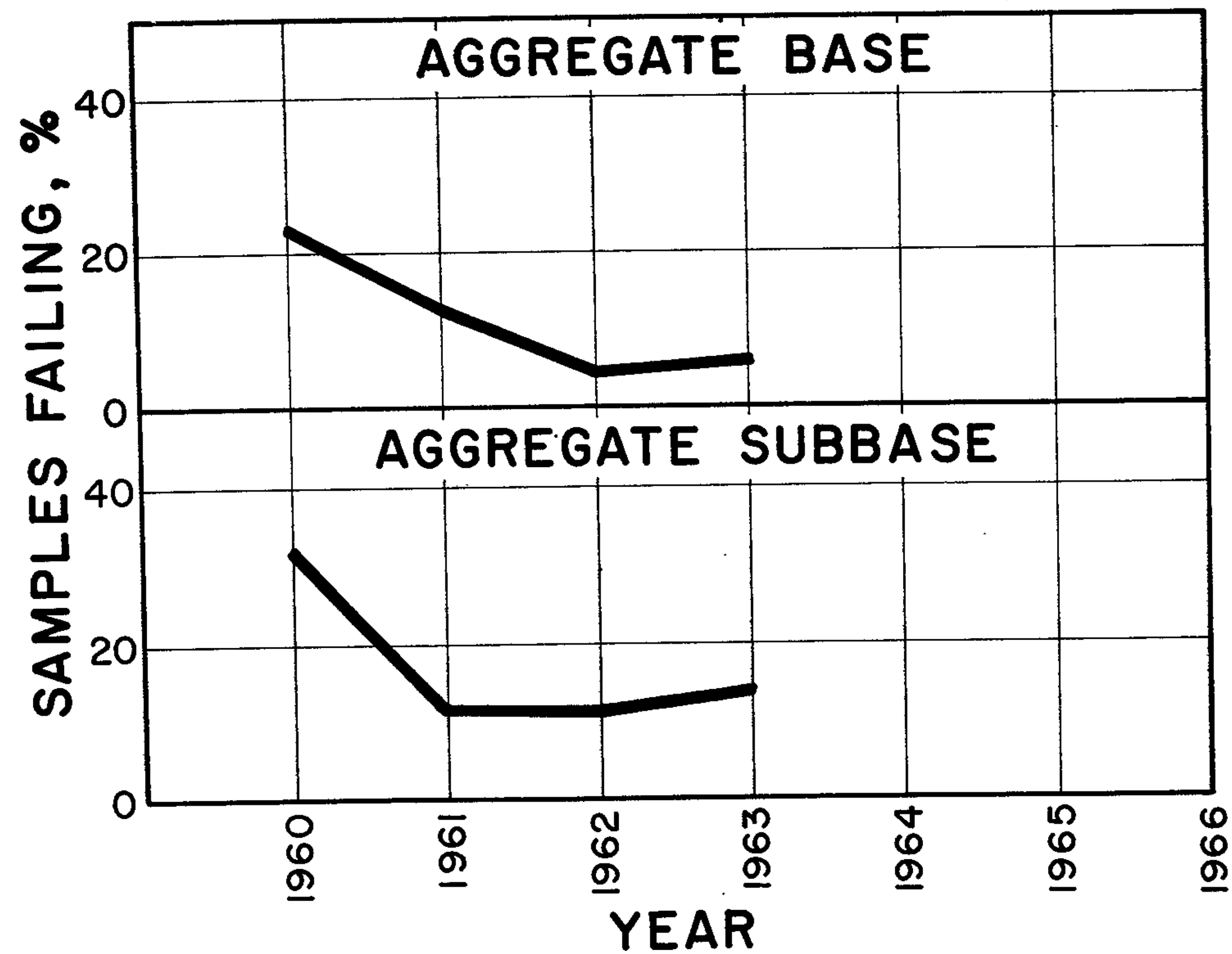


FIGURE 12

FIGURE 13

OGIVE CURVE FOR DEVIATIONS FROM THE SPECIFICATION S.E. REQUIREMENT AGGREGATE BASE

1963 RECORD SAMPLING PROGRAM

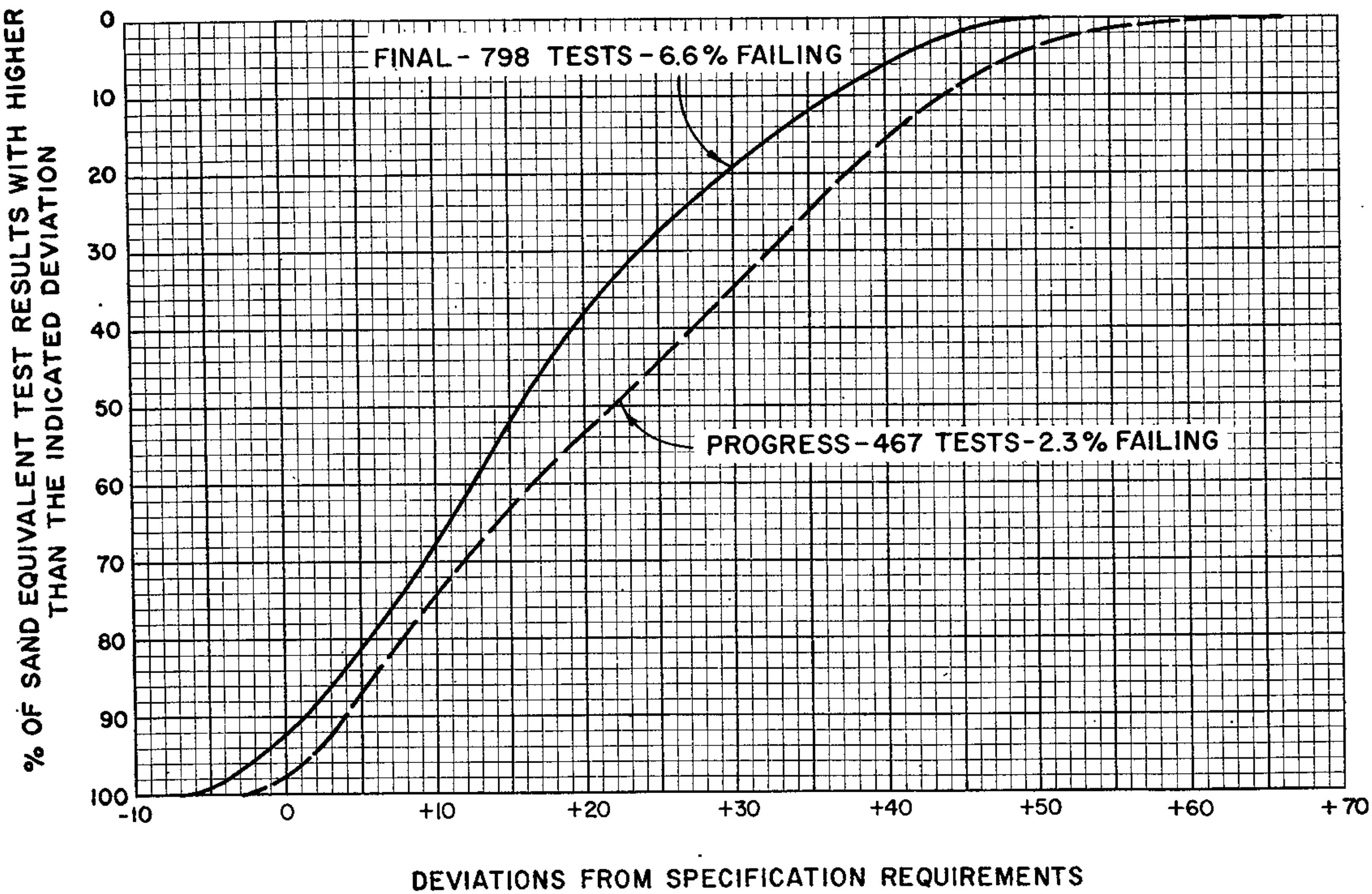


FIGURE 14

OGIVE CURVE FOR DEVIATIONS FROM THE SPECIFICATION S.E. REQUIREMENT AGGREGATE SUBBASE

1963 RECORD SAMPLING PROGRAM

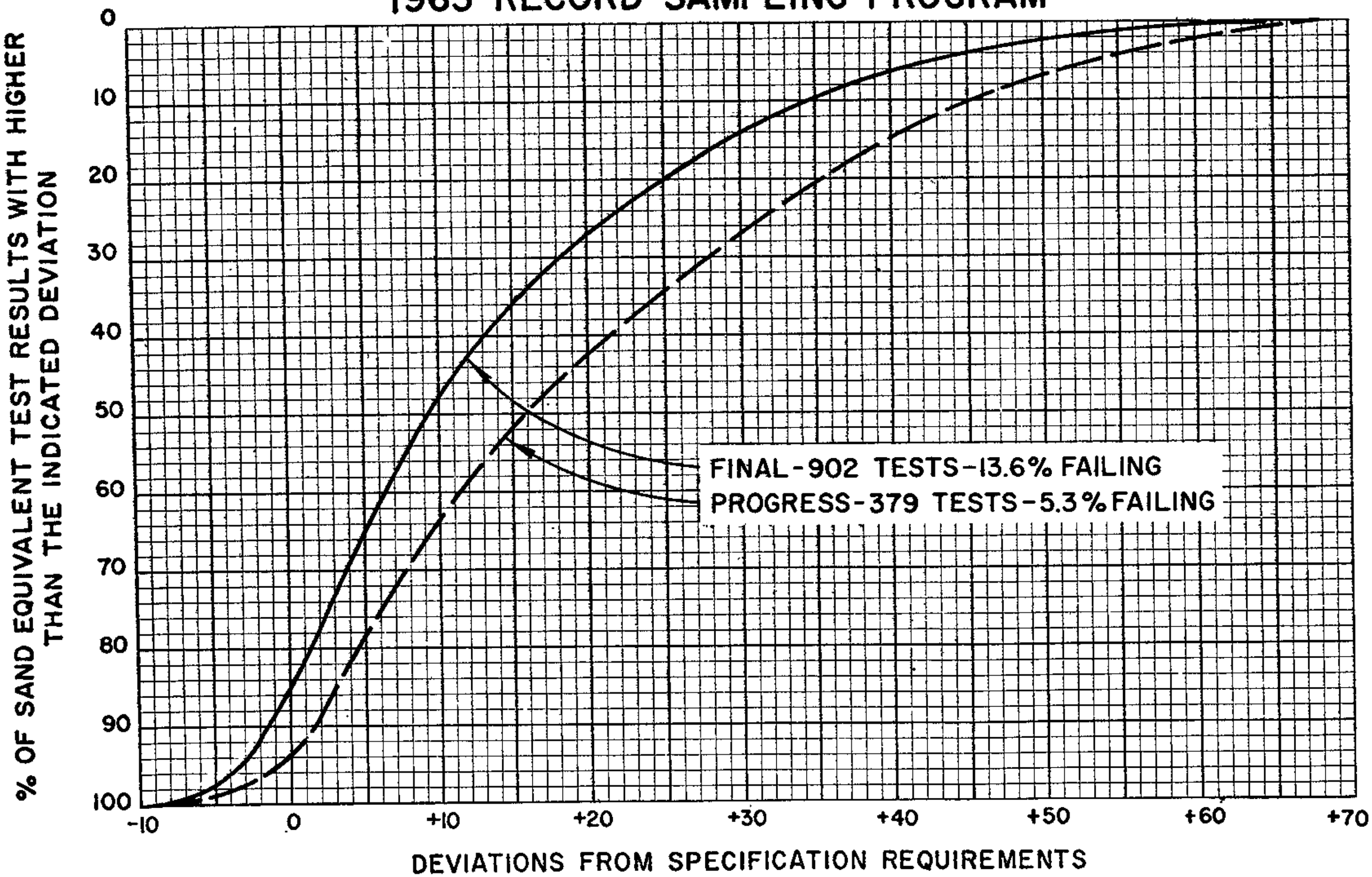
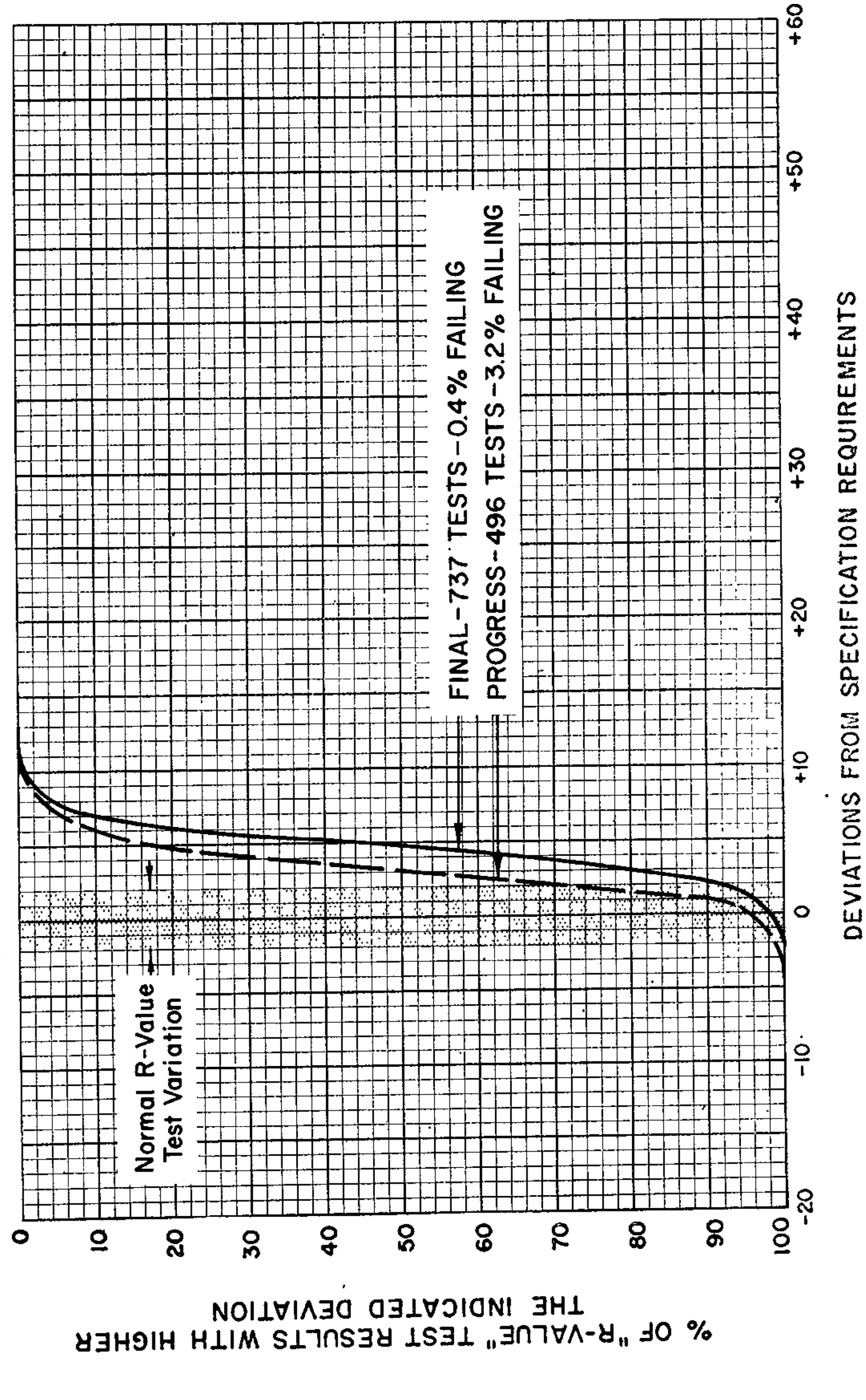


FIGURE 15

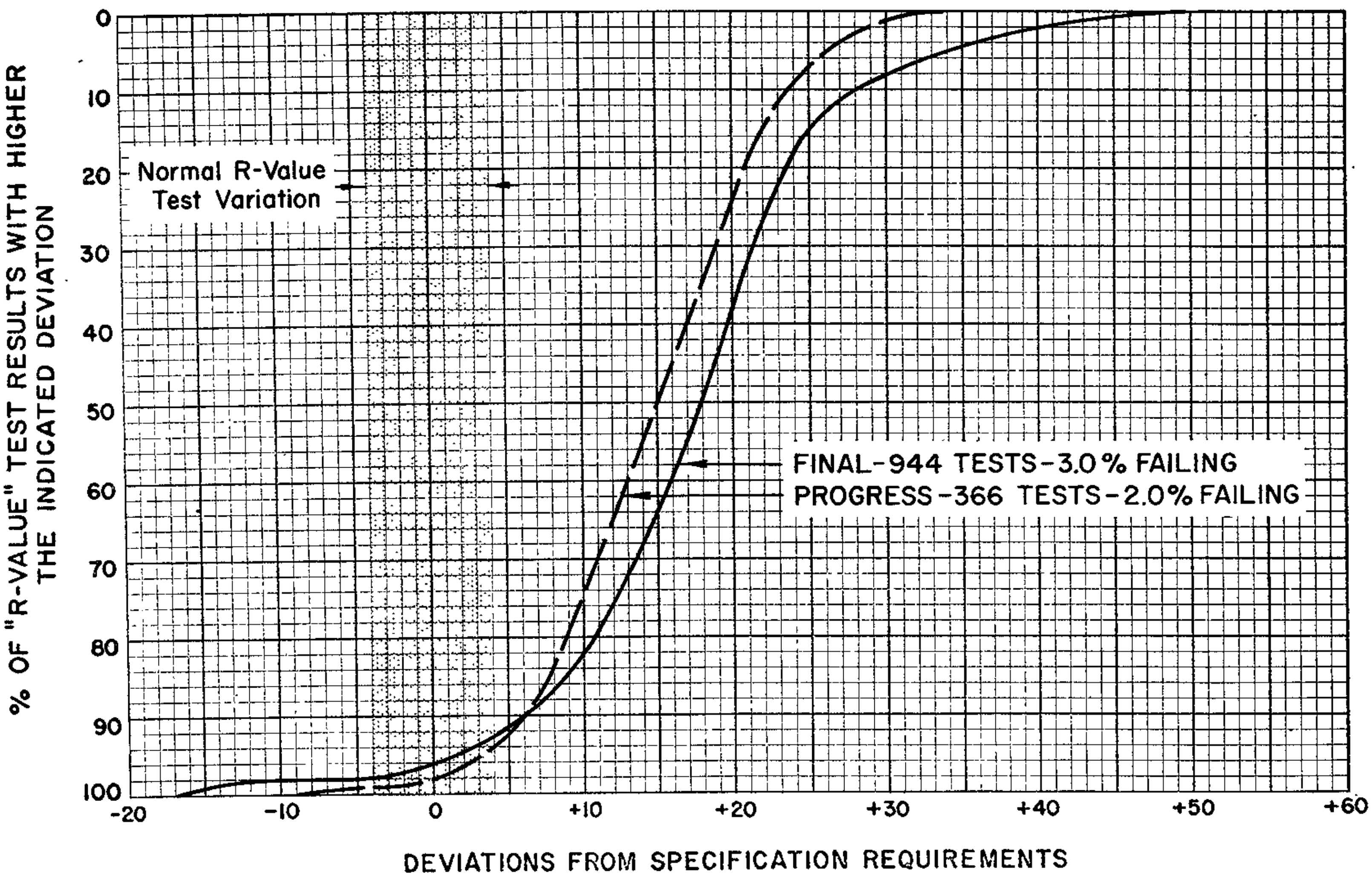
OGIVE CURVE FOR DEVIATIONS FROM THE SPECIFICATION "R" VALUE REQUIREMENT AGGREGATE BASE

1963 RECORD SAMPLING PROGRAM



OGIVE CURVE FOR DEVIATIONS FROM THE SPECIFICATION "R" VALUE REQUIREMENT AGGREGATE SUBBASE

1963 RECORD SAMPLING PROGRAM



AVERAGE PROGRESS AND FINAL RECORD (AGGREGATE BASE) (GRADING DISTRIBUTION)

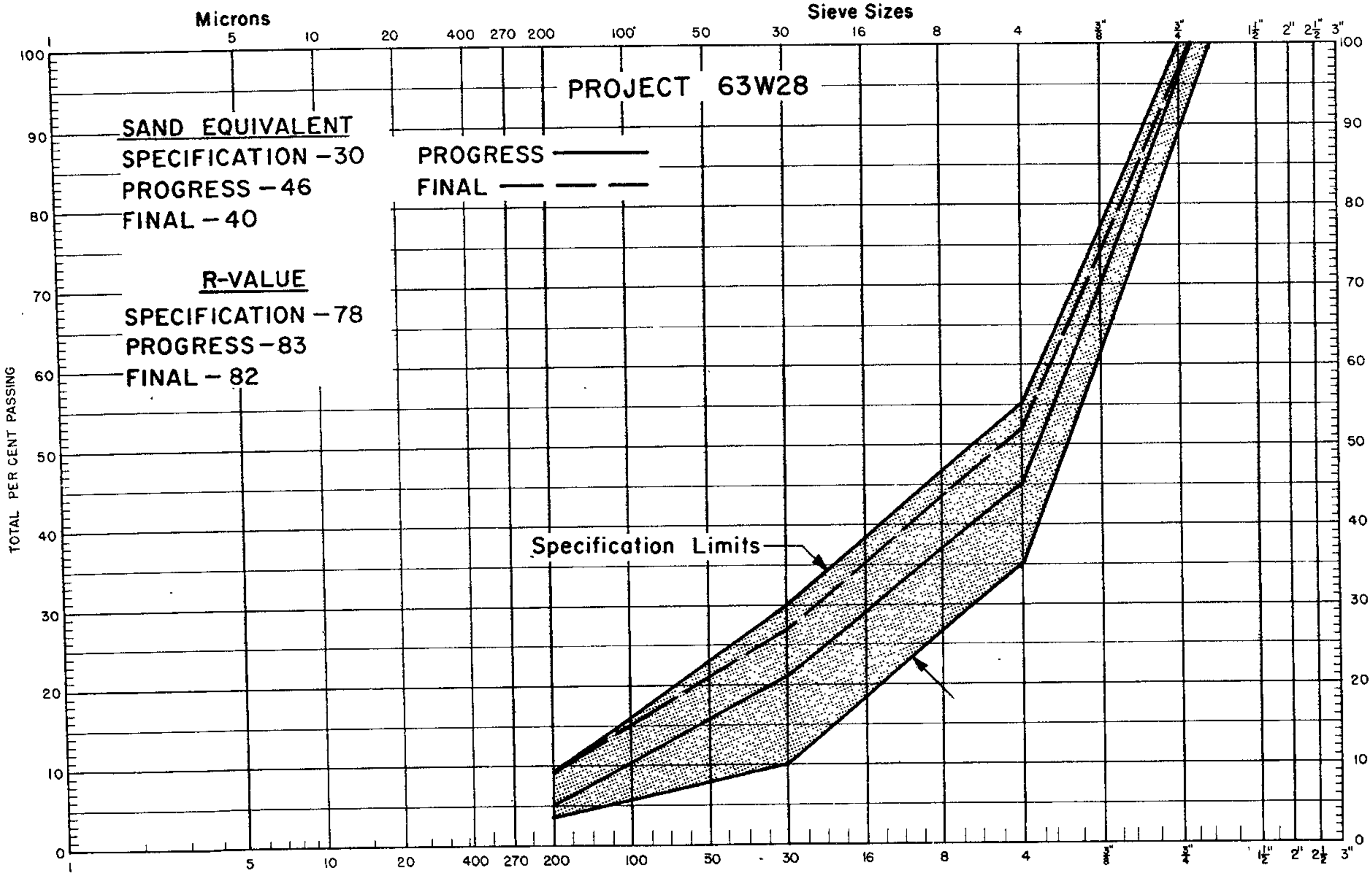


FIGURE 17

AVERAGE PROGRESS AND FINAL RECORD
(AGGREGATE SUBBASE)
(GRADING DISTRIBUTION)

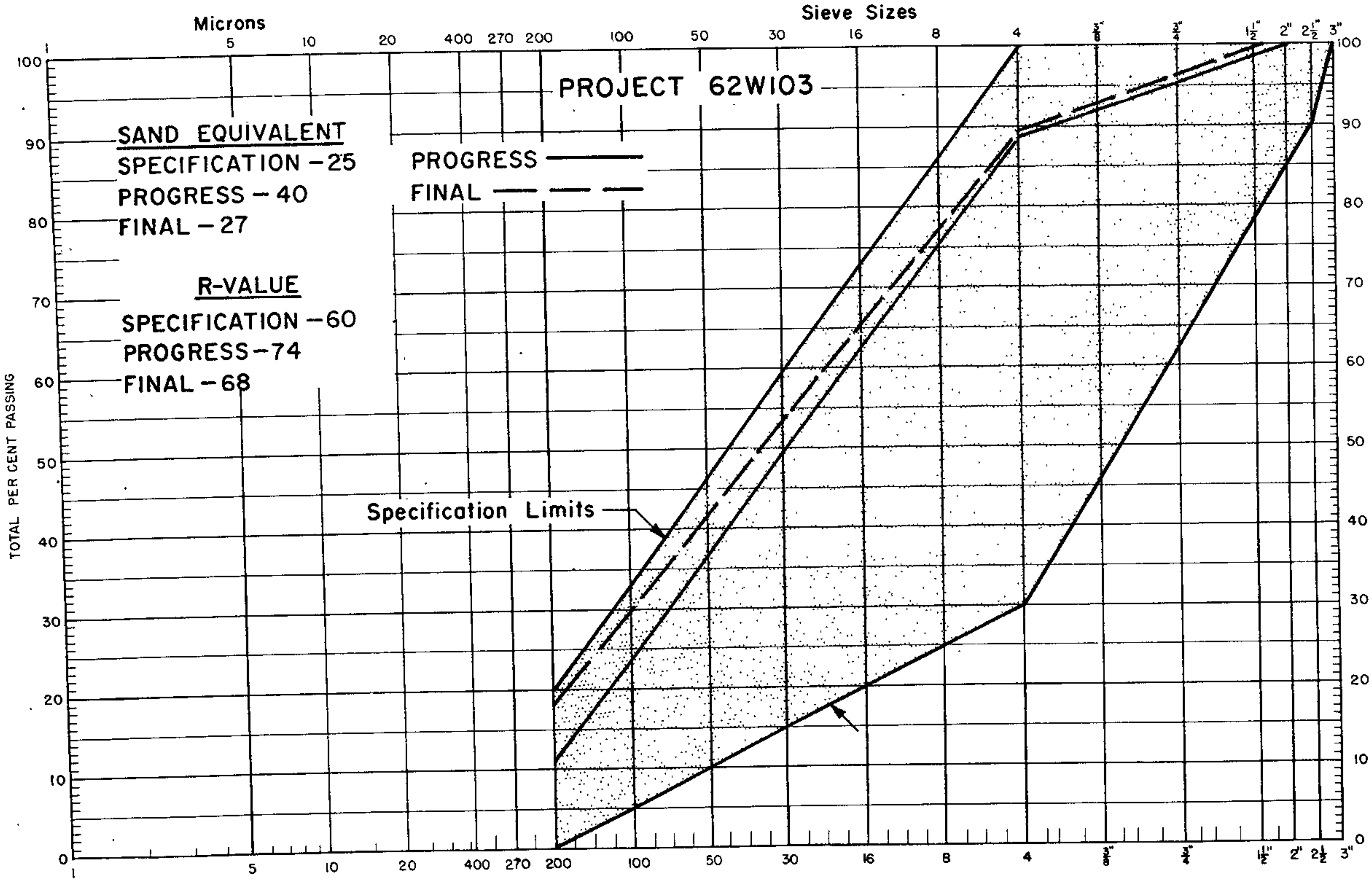


FIGURE 18

AVERAGE PROGRESS AND FINAL RECORD (AGGREGATE SUBBASE) (GRADING DISTRIBUTION)